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## Forthcoming Events.

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*British Foundrymen's Association* (Scottish Branch).—"Light Castings," by M. Riddell.

MARCH 16.

*British Foundrymen's Association* (Halifax Branch).—"Melting Iron in the Cupola and its Management," by H. Pemberton.

MARCH 19.

*British Foundrymen's Association* (Sheffield Branch).—"Mechanical Core-making," by H. S. Green.

MARCH 23.

*British Foundrymen's Association* (Birmingham Branch).—"Cast Iron: The Changes during Heat Treatment," by W. H. Hatfield.

MARCH 27.

*British Foundrymen's Association* (Newcastle-on-Tyne Branch).—Presidential address by W. R. Wallis.

## NOTES AND COMMENTS.

### The Steel of the Future.

Economic considerations have frequently been responsible for unexpected developments in the metallurgical world, giving at one time a stimulus to technical discovery, and at another time discounting the value of what has formerly been an important technical improvement or invention. When the Bessemer steel-making process was first perfected much was predicted for it, and it occupied a very important field. Twenty-two years ago the production of acid Bessemer steel in Great Britain was as great as the combined production of acid and basic open-hearth steel, while a considerable quantity of basic Bessemer steel was also made. In the year 1890 the outputs of these steels were as follows:—Acid Bessemer, 1,612,730 tons; basic Bessemer, 402,133 tons; acid open-hearth, 1,462,913 tons; basic open-hearth, 101,287 tons. The total Bessemer output was thus 2,014,863 tons, and the total of open-hearth 1,564,200. In 1910, however (the latest year for which figures are available), the position was quite changed; the open-hearth processes took the lead with a total of 4,231,569 tons, as compared with only 1,779,115 tons for the Bessemer processes. The basic Bessemer output had increased to 641,012 tons, but the acid Bessemer output had declined to 1,138,103 tons. Of the open-hearth processes, the acid still held the premier position, with an output of 2,653,033 tons, as compared with 1,578,536 tons for basic; but the development shown by the latter during the years 1905-1910 was remarkable, amounting to over 100 per cent., while the same period showed a decline in acid open-hearth steel production. From the foregoing it will be seen that the Bessemer process has not maintained its position in relation to its rival processes, and has, in fact, badly lost ground. As regards the position in France, the circumstances are somewhat exceptional, owing to the large resources of phosphoric ore which comprise their chief source of supply. In that country acid Bessemer steel has a relatively small production, while basic Bessemer contributes nearly two-thirds of the total. The examples of the other two great steel-producing countries, however, viz., United States and Germany, exhibit the same tendency of Bessemer steel production to decline. In 1910 the United States output of acid Bessemer (no basic Bessemer is produced in that country) was 66.3 per cent. of the total, but in 1910 it had declined to 36.3 per cent.; in Germany the decline over that period was from 3.4 per cent. to 1.3 per cent. for acid Bessemer, and from 63.6 per cent. to 60.3 per cent. for basic Bessemer, while in Great Britain the decline was from 25.6 per cent. to 18.9 per cent. for acid Bessemer, with a rise from 10 per cent. to 10.7 per cent. for basic Bessemer. Of the total of these three countries in 1900 the four descriptions in question contributed as follows:—Acid Bessemer, 38.2 per cent.; basic Bessemer, 21.3 per cent.; acid open-hearth, 18 per cent.; basic open-hearth, 22.5 per cent. In 1910 the proportions

were :—Acid Bessemer, 23.8 per cent.; basic Bessemer, 19 per cent.; acid open-hearth, 8.9 per cent.; basic open-hearth, 48.3 per cent.

### The Progress of Basic Steel.

The development noted in basic open-hearth steel in Great Britain would doubtless have been much greater but for the fact that the inadequate home production of iron ore renders it necessary to have recourse for about one-third of the consumption to foreign supplies, which are obtained almost exclusively from districts producing low-phosphorus ores. Since the basic processes are essentially for dealing with highly phosphoric iron, this fact conduces to the retention of the Bessemer and acid open-hearth processes. But as the world's supplies of high-grade ore become exhausted (and those at present known are rapidly becoming smaller) there must necessarily be a revertion to the less pure grades, with a corresponding disadvantage to the processes dependent on the higher-grade iron. Not only will the acid Bessemer process decline, but the acid open-hearth will have to give place to the basic. There has in the past been much prejudice against basic steel, but it is at last establishing itself as a reliable material. It must, of course, be remembered that while in the progress of industry one after another of the world's iron-ore resources become exhausted, there are many that have only just been tapped, and some even untouched; and while the Spanish fields are rapidly approaching exhaustion, new deposits of superior ores are being opened up, among others, those of the Ouenza, in Algeria, and those of Itabira, in Brazil. To what extent these will provide for the manufacture of the hematite pig-iron which is indispensable for the Bessemer converter or the acid open-hearth furnace, is a leading question for the future of the English iron and steel industry, which has insufficient home resources. Our deposits of high-grade ores—those of Cumberland and the north of Lancashire—scarcely furnish one-ninth of the total production. The Cleveland deposits are the only known resources in the country which are of any real importance; they were estimated at the Stockholm International Congress of Geology at 500,000,000 tons, having a metallic equivalent in iron of 150,000,000 tons. It would seem that under these circumstances the basic process ought to develop rapidly in England.

### The Future of the Bessemer Process.

The future of the Bessemer converter will no doubt be considerably affected by the support that may be lent to it by the electric furnace. The use of the latter for a simple finishing process, with steel from Bessemer converters, as applied by M. Héroult at certain works of the United States Steel Corporation, would greatly extend the possibilities of the Bessemer process. It would be an important development to refine in the electric furnace basic Bessemer steel destined for uses for which consumers at present require open-hearth steel. However, the production of electric steel is still of but little importance. In the United States 53,000 tons of electric steel were made in 1910 as compared with 14,000 tons in 1909, and Germany produced 36,000 tons as against 18,000 tons in the two years respectively. The electric steel industry is, however, still very much in the initial stage. If the finishing of steel in the electric furnace became general in the large steel works, the conditions of competition between the converter and the open-hearth furnace might be profoundly modified. If experience demonstrates the possibility of transforming at a slight increase in cost ordinary quality of basic steel into a product comparable with best acid open-hearth steel, the predominance of the open hearth furnace will certainly be affected. Apart, however, from this possible intervention of the electric furnace in favour of the converter, no reason for the retrogression of the open-hearth furnace can be perceived. The basic open-hearth process will remain the keystone of the iron and steel industry. The advantages which it offers, both from the standpoint of raw materials and from that of quality of product, should become of greater importance, owing to the constantly increasing severity of specifications, the growing abundance of scrap, and the exhaustion of the reserves of high-grade ore. The electric furnace will, of course find a considerable field, but rather in special steels than ordinary material, on account of the cost factor.

## High Pressure Gas in the Foundry.

In the course of a lecture delivered at Manchester University by Mr. E. W. Smith, M.Sc., of the Birmingham Corporation Gas Department, the lecturer remarked that perhaps the best that could be said for high-pressure gas in industrial heating processes was that all the effects that were obtained by means of the best type of air-blast burner correctly adjusted might be obtained more easily by means of high-pressure gas, and the latter would prove more reliable in its working. There were possibilities of a great advance in gaseous heating generally, but an improvement in a high-pressure furnace would almost invariably mean a corresponding improvement in air-blast and natural-draught furnaces, and *vice versa*. He had obtained from a Brayshaw burner under 2 to 3 inches gas pressure and 1 to 3 lbs. air pressure, results which were comparable with, but by no means superior to, the results obtained by means of high-pressure gas. A burner, whether for high-pressure gas or air blast, was only satisfactory in so far as it brought about satisfactory mixing of air and gas before the gas was ignited. The burner might better be called a "mixer," as no combustion necessarily took place at the "burner." High-pressure burners had the advantage of greater simplicity and freedom from the effect of variable pressures of gas or air; but once the proper mixture had been obtained—by whatever method—the rest depended entirely on the design of the furnace. The use of high-pressure gas had many advantages as compared with air-blast and low-pressure gas, the chief of which was that all necessity for an air blower and air pipes was done away with.

In aluminium melting by high-pressure gas the pots now lasted a month, whereas they formerly lasted only a fortnight, with a smaller daily output. But the greatest advances had been made in brass melting.

### Brass Melting.

On the question of brass melting the lecturer continued:—"This is quite a different proposition to that of aluminium melting. The temperature necessary is higher for brass, but the volume of heat required is lower. In brass melting, there is always the difficulty of the volatile zinc constituent. At the temperature necessary to melt the copper the zinc boils rapidly, and is lost in the flues. The longer the operation of melting takes, the longer is the time during which the zinc is being lost. This almost indicates that high temperature, quick heating should be adopted. This is not quite the case. In coke and oil furnaces, I am of opinion that too high temperatures are employed. This seems to be proved by the fact that in both cases the loss of zinc per ton of metal melted is invariably higher than in gas-heated furnaces. I believe the best practice is found to be to run down the scrap metal

at a moderate temperature, about 1,050 degrees Centigrade, and then, where necessary, add the ingot copper, which has been previously warmed in the flues, and raise the temperature to 1,300 to 1,400 degrees Centigrade, and maintain it at that heat until the metal reaches the correct degree of fluidity. This may be determined by placing an iron rod in the furnace, and listening for the metal to 'sing.' This occurs when the zinc commences to boil. With a gas-heated furnace, the gas is then turned off and the extra spelter added and mixed, whilst the crucible is still in the furnace, with the molten metal. Five minutes is sufficient for this stage. The metal is thus slightly cooled down by the addition of the spelter, and is then ready for pouring. The furnace cover is replaced as soon as the pot has been taken out, and the gas only turned on again when the empty pot has been replaced."

When the moulds were not ready, he continued, the metal could remain in the furnace with the gas only turned on to keep a sufficient temperature to maintain the requisite fluidity—a regulation impossible with coke. The question of the regulation of heats and the consequent effect on the loss of metal was more important than would at first appear, and too much stress could not be laid on it. A difference of 1 per cent. in the quantity of metal lost would make a difference of from 4d. to 7d. per 100 lbs. of metal melted. As the cost of fuel was never more than this figure for brass melting, any slight increase in cost brought about by using gas in place of coke was much more than outweighed on this count alone. The increased life of the pots was also a saving. Where twenty-four heats only were possible with coke, thirty were being obtained in gas-heated furnaces. This reduced the cost for pots from 4.7d. per 100 lbs. of metal melted to 3.75d. The cost of a 160-lbs. pot was 15s.

Casters preferred that the melt should occupy about 1½ hours, as this gave them time to prepare their moulds; and in order to determine to what extent this could be arranged without raising the cost of melting, a test was made with 60-40 scrap brass. The tests were carried out in a 60-lb. pot furnace, arranged with a single high-pressure burner, the burner being fixed a distance of 1 inch from the tangent to the furnace wall, and at a height of 2½ inches above the furnace bottom. The burner was fitted with a jet 0.0935 inch diameter, passing about 210 cubic feet of gas per hour at a pressure of 23 inches mercury. The metal melted consisted of 60-40 pig metal and light scrap, the pig metal being added after the scrap had been completely melted. The pot used was a standard 60-lb. graphite pot. The summary of results shown in Table I. was quoted.

In the melting of drillings and turnings by coke the usual loss was 12 per cent.; there was thus with gas a saving of 5 lbs. per 100 lbs., worth at least 1s. 6d. In strip metal casting a higher degree of fluidity of the metal was necessary. In a continuous run extending over three days with copper-zinc alloys of varying composition, the following results were obtained:—

TABLE II.

| —— | Gas fired furnaces. | Coke fired furnaces. |
|---|---|---|
| | s. d. | s. d. |
| Cost of pots, per cwt.... ... ... | 0 4 | 0 5 |
| Cost of metal lost, per cwt. ... | 0 10½ | 1 4½ |
| Fuel cost, per cwt. ... ... ... | 0 7½ | 0 4½ |
| Total cost... ... ... | 1 10 | 2 2 |

These figures, it was explained, did not take account of the saving in labour costs, the cartage of coke, removal of ashes, and many other extras connected with coke-heated furnaces. The figures given for the cost of melting metal by means of coke were claimed to be extremely low.

TABLE I.—*Summary of Results of Test*

| No. of heat. | Charge. | Time from initial charging to pouring. | Total gas used. | Cost per cwt., gas at 1s. 4d. per 1,000 cubic feet. |
|---|---|---|---|---|
| | | Hrs. mins. | Cubic feet. | d. |
| 1 | 45½ lbs. mixed scrap, 14 lbs. 3 ozs. ingot metal ... ... ... | 1 14 | 218 | 6.55 |
| 2 | 45½ lbs. mixed scrap, 14 lbs. 1 oz. ingot metal ... ... ... | 1 35 | 236 | 7.1 |
| 3 | 50 lbs. mixed scrap, 43 lbs. 1 oz. ingot metal ... ... ... | 1 15 | 184 | 5.25 |

*Tabulation of Losses.*

| No. of heat. | Total metal melted. | Total ingot metal produced. | Total loss. | Percentage loss. |
|---|---|---|---|---|
| | Lbs. ozs. | Lbs. ozs. | Lbs. ozs. | |
| 1 | 59 11 | 56 0 | 3 11 | 6.2 |
| 2 | 59 9 | 55 8 | 4 1 | 6.8 |
| 3 | 63 1 | 58 4 | 4 13 | 7.6* |

## Furnaces and Crucibles.

The following particulars of furnace construction, etc., were offered as having been found best, from actual experience, the dimensions being for crucible furnaces for all metals up to German silver:—

Distance of the centre line of the burner from the tangent to the inside of the furnace, 1 in.

Distance of the centre line of the burner from the bottom of the furnace, 2 in.

Height of the crucible stand, 3 in.

Flue area, 6 in. by 4 in., tapered to the damper.

Thickness (minimum) of brickwork, 9 in.

The face of the burner should be in line with the tangent to the furnace, and full way, 3 in. by 3 in., allowed from the burner to the furnace interior.

TABLE III—*Dimensions.*

| Capacity. Lbs. Copper. | Crucibles. Height. | External diameter at top. | Cylindrical furnace. Interior. Height. | Cylindrical furnace. Interior. Diameter. | Gas consumption per hour for copper. |
|---|---|---|---|---|---|
| | Inches. | Inches. | Inches. | Inches. | Cubic feet. |
| 60 | 11⅝ | 7½ | 27 | 10 | 200 |
| 120 | 15⅝ | 9½ | 33 | 12½ | 400 |
| 140 | 16½ | 10 | 33 | 12½ | 425 |
| 160 | 17½ | 10½ | 33 | 12½ | 450 |
| 200 | 17½ | 11½ | 33 | 13½ | 490 |

Except where very quick working was necessary, the lecturer considered that low-pressure furnaces were the more efficient and more convenient for annealing. Temperatures of less than 800 deg. C. were all that was required, and these might be easily attained in low-pressure gas furnaces. Their only disadvantage was that they took rather longer (about 33 per cent.) to heat up, and when worked to their full capacity their powers of recovery were much limited.

*During the last charge a certain amount of metal fell by accident into the furnace itself, this, to a certain extent, accounting for the high percentage loss. In all cases, however, the cost of melting and the losses might have been considerably reduced by using a deeper furnace in which a charging trunk could be used, thus enabling a larger amount of metal to be charged into the furnace at one time, and thereby reducing the heat losses. With this type of metal, the loss with coke-heated furnaces sometimes runs as high as 10 per cent. The time of heating up the furnace was not calculated in the costs, as the one heating up is sufficient for the day, and would have to be spread over the eight heats. This would be equivalent to an extra cost per heat of 0·14d.

# Vanadium in Cast Iron.

By J. Kent Smith.

At a meeting of the Birmingham Branch of the British Foundrymen's Association, held at the Municipal Technical School, Birmingham, on Saturday, January 27, Mr. J. Kent Smith, of Liverpool, gave a lecture on "Some Facts as to the Action of Vanadium on Cast-Iron." Mr. C. Heggie (Branch Vice-President) took the chair, and the audience included members of the Staffordshire Iron and Steel Institute, the Birmingham Metallurgical Society, and other kindred bodies to which special invitations had been sent.

Mr. Kent Smith said that it was only some ten years since vanadium emerged from the ranks of purely academic subjects. It was then a rather expensive metal, but to-day it was available in any quantity at a reasonable price. In fact, its price to-day was considerably less than half of what it was seven years ago. Most of the work done hitherto in connection with vanadium was in reference to steel, and he had worked with it in that connection for about eleven years. Vanadium cast-iron had only been seriously tackled during the last four years, or less, and the original commercial experiments were made by Mr. C. J. Mesta, who had an important foundry in Pittsburg. Of course, the improvements effected in cast-iron by the use of vanadium were not so spectacular as those produced by vanadium upon steel properly used and suitably hardened. But the application to cast-iron was now making steady progress, and to-day the Mesta Machine Company was making a regular business of vanadium-iron castings.

It was not possible to make a good metal out of a bad one, but if the limitations of cast-iron were recognised, improvements on it could be made by a judicious use of vanadium. Cast-iron had been described as an impure steel, but it also contained another non-metallic constituent, graphite, which imposed a limit on its strength. It was not reasonable to suppose that the introduction of any metal or metallic alloy could fundamentally affect the actual nature of that constituent. It might, however, affect its distribution. Vanadium could be reckoned as a tonic; its function was not to make bad metal good, but good metal better. Vanadium must be regarded as an ingredient of special irons. It was not now so difficult to add vanadium to steel as was formerly the case, because correct alloys had been developed to give the lowest possible trouble to the user. What had been sought and found was an alloy having high solubility and carrying with it a low melting point. The pure vanadium was never used. It was found impracticable, because it was a metal that had a melting point higher than that of platinum. An alloy consisting of two parts of iron to one of vanadium would melt at about the same temperature as that of molten steel.

That was the point at which he started in his investigation respecting the application of vanadium to cast-iron, and he found that by replacing a small quantity of the iron with silicon he was able to produce an alloy which suited his purposes exactly. Eventually, one was developed which contained about 30 to 35 per cent. vanadium, 10 to 12 per cent. of silicon, and, again, a little aluminium. The melting point of that alloy was found to be lower than that of iron. The alloy was extremely brittle, and could be readily pulverised and graded ready for use by the foundryman. He recommended its being used in pieces of about 3-mesh size, though the actual size would vary according to the quality of the iron and other circumstances. The alloy was put into the molten metal as it flowed into the ladle, as a rule, in a proportion which would give about 0.15 per cent. of vanadium to the whole mass of iron. The mixture should be poled as quickly as possible, and by using a fairly hot iron, poured into properly rammed moulds, perfect castings could be assured.

As to the silicon contained in the alloy, the 0.15 per cent. of vanadium would involve in the casting 0.05 per cent. of silicon, and that would not be a very big source of weakness in ordinary foundry iron. In the admixture of the alloy with the iron nothing should be neglected that made for thorough incorporation. But there was no trouble at all in securing this.

### Effects of Vanadium.

With regard to the effects of vanadium in cast-iron, first, and most important, vanadium was a unique scavenger. It had a high affinity for oxygen, and at the heat of molten iron it decomposed and diffused any sub-oxide which might be in the metal, doing so in a curious way and more thoroughly than did any other metal used for the purpose. The result was that vanadium oxide was carried away in the slag. Vanadium oxide was a dead fusible body, which rose at once to the surface and was carried off either in the slag or in the scab. Vanadium also had a great affinity for nitrogen, and so the first beneficial result was by reason of the unique action of vanadium in scavenging the iron, and the absolute removal of the products of scavenging. Thus, by the removal of something which tended to soften the iron, vanadium exerted a toughening tendency. He knew that it had been claimed by at least one worker that vanadium was not a scavenger. Mr. Hatfield read a Paper recently on the subject, and this point was warmly debated. But it was only necessary to watch two metals, one with vanadium and the other without, to find out whether vanadium was doing any scavenging or not. On analysis, also, a portion of the vanadium would be found in the residuals, and the iron itself would be short of that amount of vanadium.

Another change was in the way in which the iron poured, the vanadium cast-iron being very mellow in pouring. That was chiefly due to the thorough scavenging action referred to. On account of its free pouring, vanadised iron was especially suitable for delicate castings. He did not think that the grounds upon which Mr. Hatfield argued that vanadium was a non-scavenger could be admitted. These grounds were purely theoretical, and he was able to say that in practice vanadium was an extraordinary scavenger, better than aluminium. Mr. G. L. Norris, some time ago, claimed that with an average use of 0.15 of vanadium there remained in the iron about 70 per cent. of the vanadium, the remainder being used up in purifying the iron, or scavenging. As a matter of fact, more was generally used up.

Another action of vanadium was that it caused all the constituents of the carbides to be more closely packed, and so lessened the liability to the formation of slip-bands under refractory treatment, besides which, the solid solution of vanadium in the ferrite meant that a ferrite was obtained that would not allow the carbide to pass through so easily. The carbide, therefore, was not so much isolated, but was

more or less distributed, and that, of course, increased the strength. In vanadium-ferrite the carbide was emulsified and colonised, and the ferrite was rendered homogeneous and tough.

But the most important strengthening effect of vanadium was got by means of its actual presence as a constituent of the complex carbides. It had not got to be just mixed up, but was a true mixed carbide. In ordinary cases in which the carbides were of iron, manganese and vanadium, the carbide would also be alloyed with vanadium-ferrite in the pearlite made up with them. Thus a metal was got distinctly stronger, much tougher, and more resistant. Therefore, it would be impossible to give a general statement which by one figure would show everything upon which the strengthening action of the vanadium depended. With regard to the solid solution of vanadium-ferrite, there was another point which was contested. There were some who said that the vanadium did not go into that solid solution, but he had always contended that it did, and Mr. Hatfield confirmed his ideas. The experiments described in a paper by Mr. Hatfield before the Iron and Steel Institute, showed that vanadium also affected these carbides, so as to make them more permanent and not dissociate so readily. Mr. Hatfield had confirmed this by a great deal of experimental work.

For all ordinary work 0.15 per cent. of vanadium was plenty. If the iron was so bad that it could not be mended by that amount, the cheapest thing was to let that iron alone. He had said nothing of the action of vanadium on the phosphide of iron, because he had no data on that point at all.

If he could not quote any general figures as to the improvement in tensile and transverse strength by vanadium under all conditions, he could give a good number of comparative results, and he had selected a few, representing a considerable range. A cylinder iron which normally had a tensile strength of 10.7 tons, made in a cupola, was raised to 14.25 tons by the addition of 0.2 per cent. of vanadium. In America 0.2 per cent. was used very largely, because American iron required very much more than British iron. He found 0.15 per cent. sufficient in this country. Another cylinder iron had its tensile strength increased from 11.6 tons to 16.5 tons, and another, made in the air furnace, from 13.4 tons to 14.7 tons, the percentage of vanadium in both cases being 0.15. There were instances on record where 0.2 per cent. of vanadium had raised an iron normally having a tensile strength of 5½ tons to 8¾ tons; but in those cases practically all the vanadium had been removed by scavenging, and there was very little left to do anything else. Mr. Norris instanced two bars which were made side by side from the same heat, the tensile strength of one of which was 24,200 pounds, whereas the vanadised bar gave 28,720 lbs., which was almost exactly on all fours with the first example he (the lecturer) had quoted.

### Effect on Transverse and Compressive Strength.

Coming to the transverse tests, of which he had made many hundreds, he gave a few which he thought representative, taking first a bar which failed under transverse tests under standard conditions at 1,300 pounds. A bar of that iron vanadised with 0.125 per cent. sustained a transverse test up to 2,200 pounds. In another case, with a similar style of iron, the increase was from 1,400 pounds to 1,900 pounds. All the cases he was now quoting were with 0.15 per cent. of vanadium. With a fair specimen of cylinder iron, the transverse test was raised from 2,500 pounds to 3,400 pounds. Taking another iron of better quality made in an air furnace, the initial strength of 3,700 pounds was raised to 4,200 pounds. By adding 0.13 per cent. to one of the very highest grades of cast-iron he could find, made in an air furnace, the test was raised from 4,000 pounds to 4,400 pounds. These figures showed that, by the addition of vanadium, the transverse strength could be raised anything between 10 and 60 per cent. In the cases cited, the transverse strength was not increased in general by any sacrifice of deflection. But as long as the transverse and tensile tests were considered to be the only ones to be applied to iron for all purposes, these tests would not indicate the true value of the addition of vanadium to cast-iron. Service was, after all, the only true test, but the result of that could not always be waited for, and therefore tests of those special irons by some means indicative of their behaviour under something like the same conditions as in practice should be compared. It was necessary to consider the fact that vanadium on compression had raised the standard from 60 tons per square inch to 67 tons. Taking another rather harder iron which began with a compressive strength of 65.2 tons, the addition of 0.15 per cent. of vanadium raised it to 71.5 tons. With a chilled iron the increase was from 96 tons to 112 tons. Here again this higher degree of compression was got without any sacrifice of the hardness of the iron; the Brinell test gave identical results, within the limits of observation, with each bar. Naturally, if they hardened the iron, they would get some increase of compression; but in this case the hardness was not affected at all—the absolute hardness as shown by resisting indentation.

With regard to vanadium cast-iron under ordinary working conditions, such spectacular results as were afforded by vanadium steel could only be possible in the case of cast-iron after some few years of trial. There were a large number of vanadised iron cylinders in work, as the material came in greatly for such work as motor-car cylinders. Vanadised cast-iron took a perfect surface and a high polish, and seemed to wear very little indeed. Mr. Norris, in one of his Papers, stated that the New York Central and Hudson River Railway had recently ordered vanadised cast-iron cylinders for 183 locomotives, and that this decision was arrived at because after an engine carrying these cylinders had run 200,000 miles under ordinary service conditions, the wear on the cylinders was only microscopic. On another American railroad, valve bushes of vanadised iron had been working 22 months, and the tool marks were still plain upon them.

There were certain European irons which contained natural vanadium, and that might to some extent account for their recognised value where abrasive action had to be encountered. When vanadised iron was used in casting plates for moulds or dies for stamping, three times the life of the ordinary castings was being got.

It might be asked what effect had vanadium on shrinkage. Vanadium was, to a certain extent, a member of the aluminium family, and therefore it would naturally be expected to increase the shrinkage slightly, especially as it did so much scavenging work. But the increase of shrinkage was so slight that in ordinary work there was absolutely no need to change the patterns, certainly not up to four or five tons. In view of its excellent pouring qualities, the vanadised iron helped considerably rather than hindered in that respect. The freedom of pouring was a valuable factor in the case of complicated designs and frequent changes of section, and the metal would stand an abnormally high hydraulic pressure in casting. The price of vanadium fluctuated, but it worked out at about an

average of three shillings per hundredweight on a casting. He could give more than one instance he had encountered of valve bodies for the handling of large quantities of liquified gases, which gave a very high pressure and put tremendous tests on the valves, and the makers had never known a valve body made of vanadised iron to fail to pass the hydraulic tests. In the United States Navy they were using vanadised iron for all marine cylinder work, and he knew several makers of marine cylinders who were using it continuously.

One thing of considerable interest to founders in that district was the general effect of vanadium on the chill. He could not give definite figures, but if to a roll of iron containing about 0.9 or 0.8 per cent. silicon, about 0.5 per cent. manganese, and phosphorus slightly lower, 0.2 per cent. of vanadium were added, the average depth of chill in the rolls cast would be intensified by about 10 per cent. If to a soft grey iron vanadium was added, there was no chilling effect at all. That was a practical confirmation of Mr. Hatfield's remarks with regard to persisting carbide in the presence of vanadium. The resistance to wear in vanadised iron chilled rolls was extremely marked. The first pair of chilled vanadised iron rolls ever made in an air furnace showed an average life of exactly three times that of the ordinary roll with regard to wear. Putting vanadium into the chilled roll did not make the roll unbreakable. All rolls were liable to breakage, but, for wearing life, vanadised rolls would give two to two and a-half times the life of carbon steel. A fact which was not too often taken into account was that the rolls (particularly of sheet mills) wore unevenly, and had to be turned down. The improved wearing qualities of vanadised iron rolls was therefore an important consideration.

With regard to the effect of vanadium on machining costs, he could say that vanadising did not make machining more difficult. Vanadised iron was certainly more resistant to abrasion, but the machining, as they knew, did not depend entirely upon that, and in vanadised iron there was a remarkable freedom from hard spots. The result was that though the material was more closely packed, the iron was just as easy to machine as was normal cast-iron, and in some cases easier.

### Discussion.

Mr. C. Heggie said that they had had a most interesting lecture. Mr. Kent Smith must have made very extensive experimental investigation of the subject. There were some who went so far as to believe that vanadium, like a certain illustrious personage, could do no wrong in any circumstances. It would be interesting, however, if some of them, as foundrymen, had been experimenting with vanadium, to hear how far their experience agreed with that of the lecturer.

Mr. Isaac E. Lester said that he could not then see all the way with Mr. Kent Smith; in fact, he took the view that in certain irons vanadium was not at all necessary, though he was still open to conviction. Of course, on that occasion Mr. Kent Smith was dealing, he believed, specifically with cast-iron for cylinders, for which purpose he was using irons produced by hot-blast, some of it very hot-blast. Consequently, the important point was that in an iron which in itself was good and properly worked, there should be no need for vanadium. In irons or classes of iron which were pronouncedly bad for some purposes, there was no question but that vanadium must have some action, even if only mechanical, and he was glad that Mr. Kent Smith had brought forward the similarity of this action to that of aluminium. Of course, metallurgically, aluminium was a much softer metal. They had long learned the use of aluminium as a scavenging metal, for in steel it certainly took up oxygen. In regard to nitrogen, had Mr. Kent Smith made any analyses bearing upon the presence of cyanide, nitride, or any form of nitrogen in pig-iron, and in what condition it occurred; and, in what form the nitride was eliminated? He would like also to see a record giving the analyses of the different irons before melting, when melted, and after the addition of the vanadium, and showing in every case the identical change which had taken place, with records of the tensile, torsion, and other tests. He hoped that was not asking too much, because they wanted to compare these statements from the point of view of the material one was dealing with and the actual commercial result. Mr. Kent Smith told them that vanadium gave a solid solution of the carbonless portion of the iron, and that vanadium hardened the iron, and therefore argued from that point that the tensile test resulting was a higher one; the afore-mentioned analysis and records would be useful also in that connection. They were all practical men, who wanted to learn, and the question in the end was, what commercial results could be got? It did not matter what they paid for an article if in the end it gave better results than something which was doubly cheap and doubly nasty.

Mr. R. Buchanan said that he wished to speak about oxygen, because he had discussed the question with some rather eminent metallurgists, and he had asked them whether they thought there could be a free oxide in silicon grey iron. He might quote the authority of Dr. Stead, who told him that he did not think there could be oxygen in the presence of silicon in grey iron. Further than that, he (Mr. Buchanan) could not go, but he would just like to know what it was that vanadium scavenged if there were no oxides present. He believed that Professor Carpenter had pointed out that he found a considerable quantity of hydrogen present in iron. Whether or not vanadium seized upon the hydrogen, he (Mr. Buchanan) did not know, but with regard to oxygen he thought it remained to be proved that the oxygen was there to be scavenged. He could understand vanadium having that action on steel, but not on ordinary cast iron.

Mr. A. E. Tucker said that the subjects of vanadium steel and vanadium cast iron were essentially different. Everything that Mr. Kent Smith said with regard to the main results of the introduction of vanadium was, of course, worthy of the very highest respect, but, as to the causation of these results, he was sorry to say he must join issue with the lecturer. Something like thirty-five years ago he was associated with Mr. John Parry, of Ebbw Vale, who did considerable work in the examination of the occluded gases in cast irons. They found hydrogen and carbonic oxides, but they never found free oxygen. It seemed to him that the presence of oxygen in siliceous iron, or manganiferous iron, or pig-iron containing high amounts of carbon, was absolutely inconceivable. Further, he would submit that silicon itself was the one element calculated to remove any oxygen that might be assumed to be present, because, if they recalled the curves illustrating the removal of silicon in the Bessemer process, in the Siemens' furnace, and in the puddling furnace, they would see at what high rate the silicon was removed. From experiments he had made in the Siemens' furnace, he found that as soon as the metal melted the silicon was removed to the extent of something like 98 per cent.—this enormous reduction showing the great affinity of silicon for oxygen which was so characteristic of this element. Therefore, whatever the attributes were which might be accorded to vanadium, he did not think it possible to allow it that of removing oxygen. He questioned very much whether scavenging was the correct word.

It seemed to him that the action of vanadium which Mr. Kent Smith had brought forward, might be attributed to one of those extraordinary physical effects, effects of great magnitude, which were so often brought about by the introduction of certain materials in minute quantities—effects which might be either detrimntal or greatly advantageous to the mass carrying them.

Mr. F. J. Cook said the subject had been dealt with in a very broad way, and the lecturer had shown them something of the limitations of the use of vanadium with cast iron. The lecturer had spoken largely of the effects vanadium had on American iron. To an Englishman it seemed quite possible to make a vast improvement in some American irons. He was not saying that without some authority, because he had very closely studied the question of American and English irons in correspondence and also in the exchange of bars. He never got ½-in. Keep's bars from America which would not break at 430 lbs. and under, whereas he had made them to stand 800 lbs., and had sent Mr. Keep some which reached at least 600 lbs., as tested in Mr. Keep's own machine. Therefore, he thought it possible that American irons might show greater gains in strength by the addition of vanadium than it would be possible to bring about in English irons. Mr. Kent Smith started by saying that vanadium was of most use in improving good irons, but he (Mr. Cook) did not hear any figures quoted which justified that statement. The lecturer had told them of cylinder iron that varied in tensile strength from 10.7 to 11.6, but he (Mr. Cook) would not call that good iron. He could mention something over 500 consecutive tests in his own foundry where the figure averaged 16.4 tons tensile, and had been as high as 19, and was never lower than 13. The cost of vanadium seemed to him to be almost prohibitive unless very much better results than those shown by the lecturer could be obtained with it in dealing with the irons of this country. Of course, he was not disputing the results of Mr. Kent Smith's experimental work, neither was he supporting them. He had not experimented with vanadium; he had experimented largely with titanium and other metals supposed to act in the same way as scavengers, and his results had always been very unsatisfactory. He had not only had the experiments done himself, but the representatives of the companies concerned had come in and had got the same results. Test bars had been cast from the same ladles, and the more of the special elements that had been added the worse was the result. He did not consider that the lower results were due to the element that was put in, but simply that the scavenger was of no good at all as far as those particular castings were concerned, and the lower results, in his opinion, were due to the difference in the casting temperature. Putting in aluminium raised the temperature momentarily; one could see that; but whilst the temperature was quickly raised, it went back just as quickly, and the last state of the iron from this point of view was worse than the first. He always considered that this difference in the casting temperature had caused the difference in the strength of the bars. The lecturer had not referred in any way to the action of vanadium on the carbon. His own opinion was that the size of the graphite and the total quantity of the carbon were the ruling factors in the strength of a cast bar, and he would like to hear what Mr. Kent Smith had to say of the effect vanadium had in that direction, and also of the effect it had in regard to resistance to abrasion at high temperature—say, 550 degrees. He would like to associate himself with the other speakers in regard to the action due to the presence of oxides in iron. He had only made general observations, but he had discussed the matter with several eminent authorities, and all of them agreed in the opinion which he still held that there was no oxide of iron in molten grey iron.

Mr. G. Hailstone said that with what experience he had had with cast iron, he had always been under the impression, as he still was, that if good brands of iron were mixed scientifically, it would not be necessary to use any scavenger to produce good wearing properties and high tensile or transverse strength. American irons were better than English as regards the percentage of phosphorus being lower, but in ultimate stress the American irons certainly were worse. About six and a-half years ago, soon after vanadium had begun to be talked of, there were sent to him a good many papers about the influence of vanadium on steel, and he was asked to make a report as to the benefit it might have on cast iron, because it was thought that probably it could be put through the cupola with cast iron, and make the iron come out as good as steel in strength. He prepared a long report showing that vanadium in ordinary steel seemed to bind the crystals of ferrite together in such a manner as to make the steel stronger, and much more malleable under impact, and he worked out the cost. At the price at which vanadium was then it would have cost about 12s. a cwt. to give three cwts. more strength in a transverse bar, and, of course, this was out of all reason. With regard to the differences in strength given them by the lecturer—in one case an increase from 10 to 14 tons in tensile strength by adding 0.2 per cent. of vanadium—he thought they could do much better than that in that district without vanadium. As to vanadium acting on cast iron in the same way as aluminium did, they had always heard that aluminium acted in the same manner as silicon. Silicon promoted the formation of graphite. Did vanadium do that? It gave him rather a shock to hear the lecturer say that vanadium prevented porosity in cast iron. Porosity was a form of liquid contraction, and, for his own sake, he would like to know how much work had been done in that direction with vanadium.

Mr. Cook remarked that he had intended to refer to that question of sponginess. From his own observation, it seemed that a great deal of sponginess or porosity was due to the rate of cooling. From a "K" test-bar it could generally be told whether a casting would leak or not, and he was quite of the opinion that a great deal of the porosity that was experienced nowadays might be cured by pouring at a higher temperature.

Mr. H. I. Coe said he was pleased that the lecturer laid some stress upon the necessity of reducing the high melting point of rich vanadium alloys before applying them to their uses in the iron foundry. The same remark was true in the case of other alloys such as rich ferro-silicons and ferro-manganese. If it were necessary to add these alloys to fluid cast iron, they should be low-grade, or there would be danger of considerable loss due to oxidation before melting, and also danger of incomplete fusion of the added rich alloy, owing to its high melting point. He was interested to hear that Mr. Kent Smith reduced the melting point of the vanadium alloy by the addition of silicon, and he wondered if it were possible to employ carbon to perform that function instead of silicon. In respect to the improvement effected by vanadium on the mechanical properties of cast iron, the influence of vanadium was not as great as that of sulphur. According to some results he (Mr. Coe) had recently obtained, the addition of 0.08 per cent. sulphur to a siliceous iron raised the transverse strength of a 12 × 1 × 1-in. bar from 23 cwts. to 43 cwts. In another case, less sulphur (0.05 per cent.) raised the

strength to 32 cwts. It was true, the first-mentioned bar was too hard to machine, though the second was comparatively soft and was easily drilled. The addition of sulphur raised the deflection and did not confer brittleness on the metal. Again, sulphur, like vanadium, improved the wearing properties of cast iron. He also wished to ask Mr. Kent Smith whether there was any danger of vanadium oxidising while being added to the cast iron.

Mr. M. Pemberton (Derby) referring to the results the lecturer had given with regard to cylinder castings, suggested that quite as good results were being obtained in British foundries by a judicious mixing of the various grades of pig-iron without resorting to "the doctor's shop." The lecturer had told them of locomotive cylinders which had run 200,000 miles, and the wear on which was only microscopical. Could Mr. Kent Smith give them any idea of the analysis of the piston rings and the pistons? Was there any vanadium added in casting them? They could make a cylinder of any British iron and run it quite 200,000 miles without any appreciable wear if the piston rings were made of suitable metal. Therefore, it would not be quite fair to estimate the running of any cylinder without making a percentage test of the metal in the piston rings. The statements they had heard of the results of using vanadium did not seem to him conclusive with regard to irons which could be used without it, for by using vanadium in the proportion Mr. Kent Smith suggested, the price of the iron, and, therefore, of the castings, was made prohibitive, since it would raise it by £3 per ton. This, in view of the results obtained, ruled out vanadium as a commercial addition to cast iron.

Mr. George Carrington said that the lecturer had given them an analysis of what a roll should be, and had told them that the addition of vanadium to one particular roll gave it 50 to 60 per cent. greater life, more particularly with reference to sheet rolling. Did the use of vanadium make the roll break quicker? If vanadium increased the chill it was bound to harden the roll, and his experience was that the roll went, not from shock or wear, but from internal stress set up by the heat from the metal that was being rolled and the regulation of the barrel by water on the neck. Did the introduction of vanadium give the roll a greater liability to breakage, from this cause, or did it help it to resist this internal strain? In putting in vanadium, the lecturer said, there was a large increase in the depth of the chill, about 10 per cent. In a sheet roll the chill determined whether the roll was a good one or a bad one. Now, if there was 10 per cent. extra on that chill to what was generally recognised as that of a good roll, what was the result? Would it not be to turn a good roll into a bad one? If there was too much chill on the body the consequence would be that the roll would burst. Why, then, should it be necessary to put in vanadium when at the present time a good chill could be got in the ordinary way with ordinary cold-blast pigs? It was just possible that vanadium would give a better wearing surface, but, on the other hand, in a chilled roll the surface did not wear off. As a matter of fact, it was turned off, and the life of a roll was determined by the number of times it had to be turned and how much was turned off each time. In turning a sheet roll a certain amount of sweep was left in, and consequently the rolls ran largely on the two ends; this caused rolling hardness at these points, and it was this that necessitated the constant roll turning. Would the vanadium help the rolls to resist this tendency to rolling hardness? If not, obviously it could not increase the life. It struck him that the regularity of the surface would be greater in a roll cast with vanadium than in an ordinary roll of the present day, and consequently more would have to be turned off, if it did not restrict this rolling hardness.

The Chairman: I understand that that is one of the main things claimed for vanadium, that where any part of the machine is subject to shock or continued vibration it really strengthens the machine.

Mr. George Carrington: Possibly that may be so, but my point was, does it make the roll less liable to internal stress? With a roll such as is used for sheet rolling, the breakage results largely from internal stress. The bearings of the roll are comparatively cool, and the heat is driven into the body of the roll.

Mr. Kent Smith, replying on the discussion, said that Mr. Lester told them that they ought to put more cold-blast iron in the furnace. He agreed that they should; but they did not. It was said that cold-blast iron did not need scavenging so much as hot-blast did, and one speaker had quoted Dr. Stead who, as he (the lecturer) had himself told them, did not consider that molten cast iron should contain oxide. Personally, he would not like to butt up against Dr. Stead if that gentleman claimed that in that condition there could be no free oxide of iron present. His (the lecturer's) remarks referred to *oxide*, and as far as concerned the actually proved effect of vanadium in scavenging, there could be no question. If the vanadium got into the slag, how did it get there unless in company with some other material, which was probably either oxygen or nitrogen, as it was not likely to be hydrogen? The question of atmospheric oxygen was also raised by one speaker, but there never should be any danger from that. If ordinary good practice were followed, not one-hundredth part of the vanadium should be lost by atmospheric oxidation, because the vanadium was swept away and dissolved before it had the chance to oxidise. As to nitrogen, he was sorry he had no complete comparative data. It was rather difficult to make a nitrogen estimation, and further, he thought they were all still mostly in the dark as to how nitrogen did exist in steel or iron. He wished he could give more examples of nitrogen figures, but in the analysis of vanadium steel and of vanadium iron he could give two cases. Those certainly did show very much lower nitrogen than in other steels and irons, but neither of those analyses were strictly comparatively made. While vanadium ought certainly to combine with nitrogen, they had no chemical reason for supposing that it would take hold of hydrogen. Mr. Tucker had remarked that scavenging was not a good word for the action of vanadium, and seemed to hold the opinion that it was a question of a body being improved by a very small amount of something else. That was right partially, but at the same time, scavenging was one matter in connection with the advantages of vanadium, because they did not find all the vanadium in the slag, or in the metal alone. They got a certain amount in the slag, but not all that was added to the metal; therefore, the vanadium must either have done work in the iron itself or must have been carelessly used. If they could satisfy themselves that they had used it without any true loss beyond what was negligible, then a *priori*, they had reason to believe it had done something; and if it had altered the nature of the ferrite, altered it microscopically, altered it from a mechanical point of view, or even altered the gravity of the metal, then, undoubtedly, from all these points of view, it was reasonable to suppose that something had happened to the solid solution. Mr. Cook spoke about what he called the unfortunate figures which had been quoted in the lecture, namely, the tensile strengths of 10.7 and 14.25 tons. He (the lecturer) selected those figures for a particular purpose, but they did not represent by a long way the average

American iron. He was only trying to show what effect vanadium had in certain specified cases. He might have mentioned an iron with a tensile strength of 5.7 tons. Unfortunately, that was made in Birmingham—(laughter)—though he would not like to say that it was a very good specimen of Birmingham iron. There was no doubt that the size and distribution of the graphite had a great deal to do with the strength of either ordinary or vanadised iron. He could not give them any express data on the point because, unfortunately, he had not much opportunity of doing work in that direction. The work he had done was not inconsiderable, but he had not yet devoted to vanadium in cast-iron one-fiftieth part of the time he had given to vanadium in steel. There was, however, no reason to believe that vanadium either increased or decreased the *amount* of graphite. Analysis had shown that vanadised iron and plain iron of the same lot of grey metal had been practically identical in the point of graphitic carbon, or as nearly identical as any ordinary man could say. On the other hand, it was quite possible that proper investigation, such as he personally had not had the opportunity of making, would show them that the graphite in the vanadium iron was very much more advantageously distributed. Some work was done on that very point by another investigator, who found that the amount of graphite carbon was exactly the same in vanadised castings as in corresponding specimens cast without vanadium, but that the vanadium casting showed marked superiority in distribution. He did not know that these results had ever been published, but the superiority shown was most marked, which was only what one would expect from some of the other observations which had been published. Coming back to the subject of oxygen, he still personally felt that there was an oxide of some kind in the molten metal. He did not say oxide of iron, but higher authorities than himself said that there certainly was some oxide which was decomposed by vanadium. They had no reason to believe that carbonic oxide was decomposed by vanadium, but it surely was an oxide of some kind, because it was not likely that the whole of the scavenging action was due to the nitrogen content of the molten iron. Mr. Hailstone had asked if they had an iron that did not need scavenging; then why use vanadium? If vanadium did nothing else but scavenging, then Mr. Hailstone was quite right in his inference, but he (the lecturer) had tried to show that vanadium did at least three things. If they had an iron which did not need scavenging, but in which other properties were wanted, and if it were found that these could be got by using vanadium, then it was necessary from the point of view of getting the best. If one of the things claimed for vanadium had gone, as Mr. Hailstone suggested, there were still two left in favour of its use. Mr. Pemberton spoke about being able to get a much better iron than those mentioned in the lecture without using vanadium. His (the lecturer's) contention was that the transverse and tensile strengths were not everything, but that it was really something else which determined very largely the value of the metal in after life. With reference to the piston rings used with the vanadised iron cylinders, he had not the analysis, but he had reason to believe that those also contained vanadium. They were cast iron, and he did not think they would find much gun-metal used in the United States. In reply to Mr. Carrington, he would say that vanadium did not harden the rolls as the Brinell test showed, but just left the hardness where it was without vanadium. With regard to the life of the rolls, it was shown that vanadium made it two and a-half times as long, or an increase of 150 per cent. The first comparative tests showed that, and many hundreds had been recorded since, and confirmed it. He did not say in all cases "increase the depth of chill," but in ordinary circumstances vanadium had that tendency, and due allowance was made for that. As far as the wearing went, the surface of vanadium iron rolls did not pit, so that instead of having to turn off more, they had to reduce less, and therefore the roll body lasted longer; and if they were lucky enough to avoid breakages, they would certainly get more value out of a vanadised roll.

MR. CARRINGTON: Do you think vanadium would have a tendency to stop the hardening process caused by using the rolls? The trouble is that the ends of the roll get hard. Does vanadium stop the hardening of the ends of the rolls? If it does not it will not increase the life.

MR. KENT SMITH said that he could not speak as to the hardening of the ends, and was not at one with the deduction, at any rate. Vanadium ought not to affect that point one way or the other. He quite agreed that a chilled roll was liable to break up internally, and vanadium would not stop that, but it was more likely to be avoided if a better roll was produced.

At the conclusion of the discussion, a hearty vote of thanks was accorded to the lecturer.

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**Vanadium in Steel.**

Speaking recently on the action of vanadium on sub-saturated steels, *i.e.*, steels containing some free ferrite, Mr. J. Kent Smith remarked that vanadium, unlike any other alloy known, had a triple action—first, as a scavenger; second, in its reaction on the ferrites; and third, in its reaction on the pearlite of the steel. As a scavenger it removed as a fluid body the slag, the oxygen arising from the decomposition of the sub-oxide of the molten steel, and its nitrogen contents also. This scavenging action was the first undertaken by vanadium, and therefore it was imperative never to present vanadium to steel until the steel was thoroughly finished according to good practice. By thus putting the ferrite into an exceptionally pure state as regards hydrogen and oxygen compounds, the steel was toughened exceedingly. By entering into solution in the ferrite, the ferrite was toughened further, strengthened somewhat, and inherently closer packed; for which reason it was less apt to develop cleavage on slip planes. The vanadium ferrite was more resistent owing to the passage through it of the carbides thrown out at the connecting temperature. The increase of tensile strength imparted by vanadium must depend upon the amount and nature of the carbides to be influenced; hence the proportioned increase could be adjusted through a wide range. The tensile strength was not responsible for one-tenth of the serious failures of properly designed steel parts. It was rather the lack of dynamic value, which value would be conferred by vanadium, which was responsible for most accidents to working steel. Vanadium in steel was not to make bad steel good, but good steel better. It might be said: What about steel poison by oxygen and nitrogen contents? In this case vanadium must be counted as a purgative. Vanadim eliminated both oxygen and nitrogen.

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MODERN FOUNDRY MACHINE APPLIANCES.—In dealing, in our last issue, with the lecture by Mr. H. S. Green, before the Halifax Branch of the British Foundrymen's Association, we neglected to state that the photographs illustrating the appliances described were reproduced by the courtesy of the London Emery Works Company, of Park, Tottenham, N., who are the makers of most of the apparatus described.

# Brasses and their Manufacture.

By J. Edwards.

Before the London Branch of the British Foundrymen's Association, on February 9, a lecture on "Brasses" was given by Mr. J. Edwards, of the Royal Arsenal, Woolwich. An abstract of the lecture, which was illustrated by lantern slides and specimens, is given herewith.

### Composition and Raw Materials.

Nominally, brass should contain only the two metals, copper and zinc, in proportions varying according to the purpose for which the metal is intended; many varieties, however, contain appreciable amounts of iron, tin, arsenic, or lead. Bismuth and antimony are also sometimes present, but even in small percentages both of these elements are usually considered to be very undesirable intruders, particularly in brass to be used for rolled sheet or drawn bars. Iron, tin, arsenic, or lead are not particularly harmful if present only in small amount; in fact, either or all of them are sometimes purposely added with a view to imparting some special quality to brass, such as strength, solidity, or good machining properties.

As much as 2 per cent. of lead is frequently added to brass, either for bars or casting upon which considerable lathe or other machine work has to be put, as it causes the metal that is removed to fall away from the tools freely.

It was formerly the practice to purchase brands of copper and zinc on the basis of their reputation or of their proved suitability. It is now, however, becoming common practice to purchase to specifications defining the nature and amount of permissible impurities. Brass for critical purposes requires pure materials, which should be purchased on specification. Copper and zinc of excellent quality, comparatively free from impurities and well suited to meet general foundry requirements, can be readily obtained, and less pure materials at slightly lower rates are used for less exacting purposes. In recent years electrolytic refining of copper and zinc has been so perfected that either metal may be obtained of 99.9 per cent. purity, and the cost is about equal to that of the best of the old approved brands.

These pure materials are a boon to foundries engaged in the manufacture of brass that is required to comply with exacting specifications. Zinc being invariably cheaper than copper, there is a tendency to use in the preparation of brass as high a proportion of zinc as is consistent with the purpose for which the metal is intended.

The three most useful copper-zinc alloys are those consisting approximately of:—Copper, 70, zinc, 30; copper, 60, zinc, 40; copper, 80, zinc, 20. Brass of the former (70-30) composition is extensively used for sheet, tubing, rod and wire. It may be readily rolled or bent in the cold state. It is very sensitive to work put upon it by rolling, hammering, or drawing through dies, and also to heat treatment. Great variation in hardness, toughness and strength may be obtained from it as a result of judicious application of work and annealing.

The second alloy, or 60-40 brass, is used extensively for castings made in sand moulds, and gives sharp, clean castings, with the advantage of being comparatively cheap and good. It forges well at a dull red heat, and lends itself to the production of drop forgings. Quite simple castings in sand or iron moulds may be made to conform to accurate dimensions, by being raised to a red heat and placed in a die under a drop hammer, one blow from which is usually sufficient to make the metal conform to the desired shape; 60-40 brass raised to suitable temperature may be extruded under pressure through dies having the section of the bar, rod or tube required. The extruding process is carried out in a manner analagous to the familiar method of squirting lead into tubing and rod. The extruded rod is very strong, and, possessing good machining qualities, is in great demand for the stock bars used on automatic and capstan lathes. For this purpose the metal usually contains lead up to 2 per cent.

The 80-20 brass is employed when a material softer than either of the foregoing types is desired. It works well in the cold, but cannot be manipulated in the hot state. In qualities and microscopic structure it much resembles 70-30 brass. It is not much in demand, probably owing to its high cost due to high content of copper.

### Furnaces and Crucibles.

Brass is usually melted in plumbago crucibles heated in coke-fired furnaces of the ordinary vertical type, having a flue connected with a chimney sufficiently high to induce the draught necessary to burn the hard coke used as fuel as a rate such as to generate the required temperature. Crucible furnace melting is generally preferred for brass. The crucible may be covered with a lid, or the surface of the metal may have a protecting layer of coke dust or other material to prevent volatilisation of zinc or the entrance of any foreign matter. The metal may also be readily stirred to ensure uniformity in composition. Other types of furnace, such as the reverberatory and the cupola, are sometimes used, particularly when heavy castings are being made; but in these furnaces the loss of zinc during melting is higher than in crucibles.

Plumbago crucibles should last from 30 to 35 heats for brass foundry work, with a less number of heats if melting for strip.

As regards the coke, it pays to use a good quality. It can be obtained with not more than 5 per cent. ash. A good coke for the pot fire should have low ash, low sulphur, and be hard. It is necessary to keep a careful eye on the consumption of fuel. This depends on the space between the crucible and the walls of the furnace. The furnace should allow a space of about 2 in. all round the crucible, and if it follows in shape the contour of the crucible, considerable economy results. Special bricks for the construction of circular furnaces can be got, and though at first outlay these are more expensive, they are more economical.

The furnace tends to wear away at about 6 in. from the bottom before the upper part is touched. It is therefore advisable to maintain the furnace at its original size by patching up with a mixture of 1 part old firebricks, 2 parts old crucibles, and 2 parts fire-clay, broken and ground up similar to ganister.

### Charging, Melting and Pouring.

When preparing for the manufacture of 70-30 strip the materials used are:—Copper, 130; zinc, 68; brass cuttings, 132. The first and third are first melted in the pot, and the zinc is then added. It is necessary to use some material as a flux, and

for this purpose may be used a mixture of 1 oz. borax, 2 ozs. salt and 12 ozs. charcoal. The latter reduces the oxides, and prevents the zinc from being lost by volatilisation. For ordinary brass-casting work the flux above mentioned is not necessary, it being sufficient to use a little coke dust on the charge. Some foundrymen, in fact, only throw on a little sand.

Considerable economy in coke is effected by the use of large crucibles, as was shown by an experiment by the author comparing 330-lbs. charges with 120-lb. charges.

It is essential for a good mould to have sand that is fine enough to take an imprint of all the sharp lines of the pattern, and yet sufficiently open or porous to allow gases to escape freely.

To ensure solidity in brass castings deadheads should be on the generous side. The section of the casting rather than its weight should be the determining factor in deciding on the position and the amount of deadhead.

Brass that is intended for sheet or rod is poured into cast-iron moulds which are usually in two parts, cramped together, so as to admit of ready removal of the ingot when solidified. The ingots are usually of plain rectangular section, but they may be of any form that will admit of ready removal from the mould. Before use, it is necessary to heat cast-iron moulds to a suitable temperature, and to coat the surfaces that will be in contact with molten metal with some substance which is a good non-conductor of heat and which experience has proved to be conducive to the production of sound castings with a smooth skin. Plumbago, tallow, lime, resin, oil, soap, or a combination of two or more of these are used. A dressing which answers well for one alloy is not necessarily suitable for another. To obtain clean and sound castings in iron moulds the metal must be carefully poured into the moulds, the rate of pouring being governed by the section of the casting and the temperature of the metal. Metal intended for strip, bar, or sheet, is cast into ingots much thicker than the thickness of the finished material. This permits of work being put upon it by a series of passages through the rolling mill, by which it is much improved in quality, reduced in thickness and increased in length.

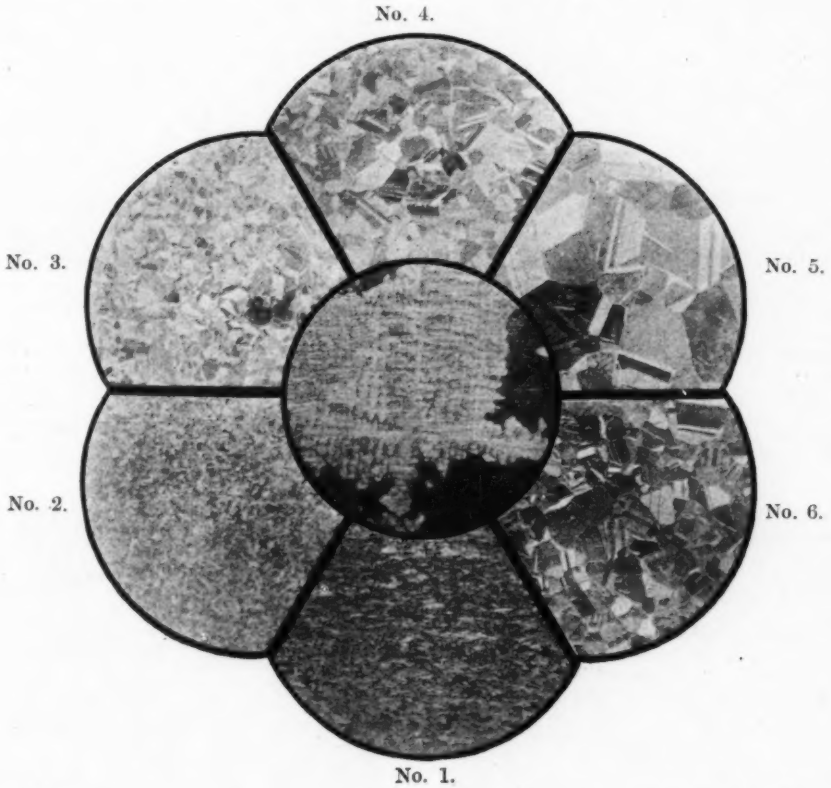


FIG. 1.—SHOWING MICROSTRUCTURE UNDER VARIOUS HEAT TREATMENTS OF 70-30 BRASS. CENTRE, CHILL CASTING; NO. 1, HARD-ROLLED STRIP; NO. 2, ANNEALED AT 500 DEG. C., FOR HALF-AN-HOUR; NO. 3, ANNEALED AT 600 DEG. C., FOR HALF-AN-HOUR; NO. 4, ANNEALED AT 700 DEG. C., FOR HALF-AN-HOUR; NO. 5, ANNEALED AT 850 DEG. C., FOR HALF-AN-HOUR; NO. 6, ANNEALED AT 600 DEG. C., FOR FOUR HOURS.

### Rolling and Annealing.

Brass castings are in a soft condition, whether they are allowed to cool gradually or are quenched from a red heat in water; hence the casting, after trimming and the removal of deadhead, may be repeatedly passed through the rolls, receiving a reduction in thickness each time, until it has attained such a reduction in thickness and has acquired such a condition of hardness, as to suggest the desirability of an annealing before further reduction by rolling is carried out.

Annealings and series of rollings are alternated until the desired thickness has been reached, when the strip may be left in the hard condition as it leaves the rolls, or be passed to the annealing furnace to be annealed to any desired extent.

The amount of reduction that may be given in one passage through the rolls is dependent on thickness of metal, condition as to relative hardness, and on the power of the rolling mill. A strong mill will take a cold 70-30 brass casting 2 in. thick and reduce it to 1 in. thickness in five passes; the metal would then receive the first annealing. The second series of rollings would reduce the thickness to 0.5 in. thickness in four passes, when the second annealing would be given. The third series of rollings—three passes—would reduce the brass to 0.25 in. thickness, when it would receive its third annealing and be returned to the rolling mill for the fourth series of rollings—four passings—and be finished at 0.1 in. thickness, when it would either be retained in its hard, rolled condition, or would be returned to the furnace to receive any desired extent of annealing.

Annealing may be most economically carried out on brass—taking into consideration time occupied and fuel consumed—with a furnace temperature of from 600 to 700 deg. C. The higher temperature may only be considered safe when the passage of the brass through the annealing furnace is controlled automatically, assuring uniformity of the time during which any part of the brass is exposed to the furnace temperature. In practice it is wise to aim at the mean of these temperatures, viz., 650 deg. C.

The microscope gives welcome aid in the examination of brass, reveals defects, enables the metallurgist to form an opinion of the effects produced by any combination of the constituent metals in alloys, and greatly adds to the value of mechanical test results obtained from specimens of alloys under consideration. It affords indications for modification in composition or treatment of metal that may be desirable to enable required conditions to be met or specifications to be complied with. In conjunction with photography it also allows a permanent record of results to be kept.

Chemical analysis detects injurious impurities, locates and measures losses, and determines whether correct or approved proportions of the constituent metals in alloys have been attained, and reveals the exact composition of any metal submitted for reproduction.

Pyrometers are of very great assistance when definite temperatures are required, especially with annealing. For molten brass, however, no pyrometer is of use in general work, as a junction is spoiled every time the temperature is taken, when a junction is used; while the fumes from the metal prevent the use of an optical pyrometer. In casting operations the acquired skill of the worker has largely obviated the necessity for pyrometers, but in the annealing of strip, where time and temperature are of great importance, it is not safe to rely on the judgment of the workman, as a number of factors tend to make his judgment unsound.

As regards mechanical testing, the old method of pouring a bar, nicking and breaking it, is no use at the present time; careful mechanical tests are necessary to determine the best way of treating the metal.

*Mechanical Tests of Brasses.*

| Type of Material and Treatment. | Tensile Stress. | Yield. Point. | Elongation. | Shearing Stress. | Brinell's Hardness Number. | Contraction of area |
|---|---|---|---|---|---|---|
| | Tons per sq. in. | Tons per sq. in. | Per cent. | Tons per sq. in. | | Per cent. |
| Composition, 70 : 30 :— | | | | | | |
| Hard rolled strip | 53.6 | 40.2 | 9.5 | 28.2 | 143.0 | — |
| Very soft strip | 21.4 | 6.7 | 91.0 | 14.8 | 45.0 | — |
| Strip annealed 450° C. | 23.65 | 10.77 | 54.1 | — | 54.8 | 60.3 |
| " " 650° C. | 20.95 | 8.02 | 65.8 | — | 41.0 | 64.4 |
| " " 850° C. | 19.25 | 6.05 | 73.8 | — | 31.9 | 56.9 |
| Drawn rod | 28.5 | 24.1 | 41.5 | — | — | — |
| Annealed drawn rod | 21.6 | 6.6 | 82.0 | — | — | — |
| Chill casting | 16.25 | — | 80.0 | — | — | — |
| Composition, 60 : 40 :— | | | | | | |
| Strip annealed 600° C. | 24.4 | — | 52.0 | — | — | — |
| " " 700° C. | 25.2 | — | 49.7 | — | — | — |
| " " 800° C. | 25.0 | — | 52.0 | — | — | — |
| " " 850° C. | 24.5 | — | 52.0 | — | — | — |
| Cast in chill | 26.0 | 8.0 | 46.0 | — | — | — |
| Composition, 80 : 20 :— | | | | | | |
| Chill casting | 16.25 | 4.0 | 82.5 | — | — | — |
| Strip annealed | 19.95 | — | 55.33 | — | — | — |

*Brass* 60—40.

| Number. | Yield point. | Tensile strength. | Elongation % on 2" | Elonga- Brinell's hardness number. | Treatment. |
|---|---|---|---|---|---|
| | Tons per sq. in. | Tons per sq. in. | | | |
| 1 Fig. 2 | 6.2 | 23.5 | 42.5 | 31 | Sand casting. |
| 2 Fig. 3 | 8.5 | 25.0 | 42.0 | 34 | Chill casting. |
| 3 Fig. 4 | 13.7 | 28.5 | 36.0 | 39 | Chill casting forged. |
| 4 | 9.5 | 29.0 | 38.0 | 33 | Chill casting forged annealed 650° C., ½ hour quenched. |
| 5 | 9.0 | 26.0 | 43.0 | 31 | Chill casting forged annealed 650° C., ½ hour slowly cooled. |
| 6 | 8.8 | 28.5 | 41.5 | 32 | Chill casting forged annealed 650° C., 9 hours quenched. |
| 7 | 6.5 | 25.0 | 50.0 | 31 | Chill casting forged annealed 650° C., 9 hours slowly cooled. |
| 8 Fig. 5 | 12.7 | 28.5 | 18.0 | 42 | Chill casting forged annealed 850° C., ½ hour quenched. |
| 9 Fig. 6 | 7.2 | 24.0 | 39.5 | 30 | Chill casting forged annealed 850° C., ½ hour slowly cooled. |
| 10 Fig. 7 | 39.5 | 46.5 | 10.0 | 70 | Chill casting forged, cold rolled from 1 in. to ¾ in. |

## Discussion.

Mr. F. J. Emblem expressed surprise at the low number of heats which the lecturer got from his crucibles, and stated that he (Mr. Emblem) averaged about 60. He also desired to know why 70-30 brass was used when 60-40 gave a better tensile strength.

Mr. Edwards here replied that he should never think of using 70-30 brass for ordinary casting work, since 60-40 was much the better metal for castings, it was stronger, easier to cast, and cheaper. But 70-30 metal was the more suitable for strip manufacture.

Mr. Willis, after commenting on the large field of research open in connection with brass founding, owing to the great variety of alloys used and the very varying conditions of manufacture and use, remarked that despite Mr. Edwards' recommendation that the raw materials should be bought on analysis, the bulk of the work done in London and district was with unknown metals; for the majority of the London brass founders buying by analysis was out of the question, largely for commercial reasons. A few large shops with chemists were better situated, but the majority had to take what metal was given them, and make the best of it. Further, the lecturer had given as his flux for brass, 1 oz. borax, 2 ozs. salt, and 12 ozs. charcoal; he (Mr. Willis) considered salt bad, at its generated chlorine fumes to the discomfort and injury of the men, and also it cut out the pot rapidly. The lecturer had ignored glass as a covering for the metal; but if glass was put into the pot before the metal it helped to carry off the impurities, formed a protecting cover, and did not act on the pot.

Fig. 2.—60-40 Brass, Sand Casting; Mag. 36 Diam.

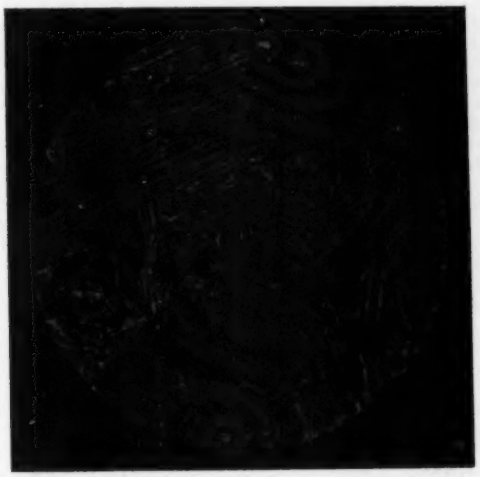

Fig. 3.—60-40 Brass, Chill Casting; Mag. 36 Diam.

Mr. Dran agreed with the lecturer in general, but he did not care about salt as a flux. At the same time, he considered glass worse, and believed that what good it did was the result of the borax and lead in its composition.

Mr. Ellis desired to know whether Mr. Edwards ever met with lamination in his metal.

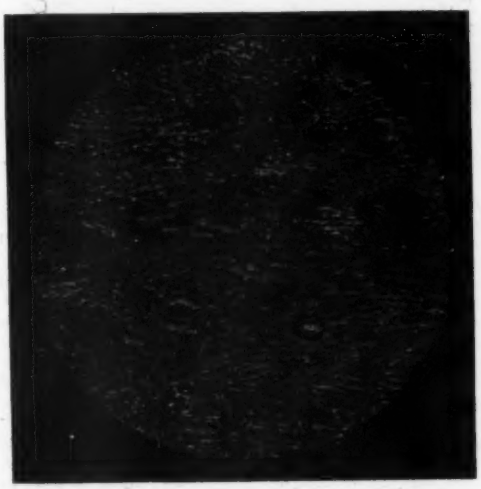

Fig. 4.—60-40 Brass, Chill Casting, Forged; Mag., 36 Diam.

Fig. 5.—60-40 Brass, Forged. Annealed at 850 Deg. C., for Half-an-hour, and Quenched; Mag. 36 Diam

Mr. Nash, regarding impurities in metals, remarked that he had used up fire-box plates containing as much as 2.5 up to 5.0 arsenic. In connection with

coke consumption, he preferred a 150-lbs. pot as being more economical than the large pot. If five or six heats per day could be got from a 150-lbs. pot, it was better than getting two from a 330-lbs. pot, while the pots themselves were easier to handle. He also asked whether the lecturer had had any experience with a very refractory brick, and what was the best such brick.

Mr. Willis, referring to the use of fire-box copper, stated that he had had great difficulty with that class of scrap. At one time it could be depended upon, but of late years it seemed harder and lighter. He had exercised every precaution in melting it (under charcoal), using the lowest possible temperature to avoid over-heating, and watching it carefully the while; and he had poured it so thick that the end had to be dragged out of the pot, and yet it had turned out spongy. Unless it was soaked with lead in alloying it, spongy places showed on any part of the casting that was polished.

Mr. Dran here remarked that if the previous speaker had wished to make his copper spongy he could not have employed a better method than the slow melting described. The fault was not in the metal, but in the method.

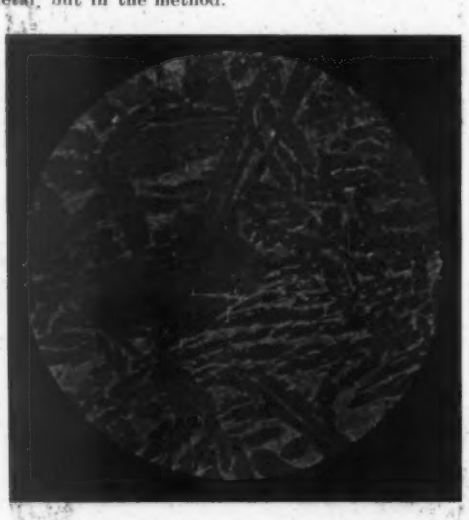

Fig. 6.—Same as Fig. 5, but Slowly Cooled; Mag., 36 Diam.

Mr. Ellis suggested that since manganese bronze and other alloys were now used for locomotive fire-boxes, stays, etc., this might account for some of the trouble.

Mr. Worton asked the lecturer what percentage of reduction of area in drawing brass would give the greatest tensile strength?

Mr. Beebe: What is the difference in coke consumption between the square furnace and the round furnace?

Mr. Pemberton asked whether the lecturer could say what was the difference in cost between oil, gas and coke for furnace firing. He could not see why it was necessary to add borax and salt in a zinc alloy. Personally, he found a little ground fluor-spar to be better than salt or glass. Mr. Edwards had said that in large castings the metal should be colder than for light work. He (Mr. Pemberton) agreed that the first metal might be colder, but the last metal in the head should be hotter than the first, to allow proper feeding.

Mr. J. Edwards, replying to the discussion and questions, said that, in respect to crucibles, a larger quantity of metal could be got out of a tilting furnace, with a resulting greater economy, if plenty of work was being done. Also, a better temperature was got with a tilting furnace. A question had been asked as to the relative advantages of casting respectively in sand and chills for strip. He considered casting in sand for strip as quite impracticable; to cast in chills was much cheaper, and gave a more solid job, 85 per cent. of the metal cast in chills being fit for the rolls. On the question of analysis, he did not mean to infer that it was necessary to analyse all raw materials, but that if uniformity was to be maintained and specifications met it was far better to begin by knowing what was in the materials being used. For brass castings in general, a different class of material was used to what was employed for strip, and a good percentage of what would be deleterious impurities in the latter work might with advantage be present. Answering the criticisms regarding the use of the borax-salt-charcoal flux, he would like to see whether his critics had ever tried those materials under the conditions for casting strip metal. For ordinary castings, he himself used only coke dust as a covering, while in Birmingham soda-ash was very largely used. Salt

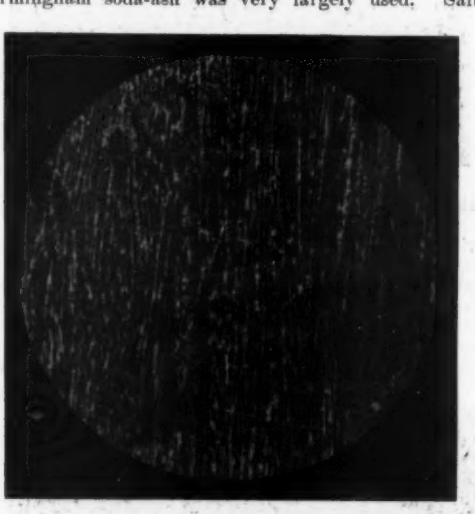

Fig. 7.—Chill Casting (60-40) Forged, Cold Rolled from 1-in. Round to $\frac{5}{8}$-in. Round; Mag., 36 Diam.

would not injure the pot, as it was not in it long enough, being added only just before pouring, and his experience gave no evidence of bad effects from the chlorine fumes being felt by the men. As to the relative costs of melting by different fuels, he had available no comparative data, but personally he preferred coke. The lamination in a plate casting mentioned by Mr. Ellis probably resulted from occluded slaggy matter. He (the lecturer) had had no experience of the effect of arsenic in copper, but he regarded it as undesirable in copper castings. It was used in pure copper castings, but he preferred manganese in the form of cupro-manganese. One speaker had asked why large crucibles were used when a larger output could be got from more heats in smaller crucibles. He denied that this was the case, as his experience showed to the contrary, the large crucibles giving the best output, while there were distinct advantages in the use of the larger pot, which did not require much more handling. As regards refractory bricks, the best brick he ever used was one known as "Martin's Lee-Moor," which was a fine, white brick made from the refuse of the China clay

settling ponds. Fire-box copper he regarded as a rough class of material for castings; he had not used it himself, and pitied any founder who was compelled to use it for good work. In reply to Mr. Worton, brass rod, 3½-in. diameter, raised to a forgeable temperature and reduced to 2-in., would give very good strength. The final results in such cases, however, depended on the work put on, and the temperature of the material when that work was done. The difference in coke consumption between square and round furnaces, he said, was very marked in favour of the latter, though he had no definite figures available. As to the question of gas *v.* oil, he could only say that he would not instal gas firing for pot furnaces. As to Mr. Pemberton's criticism of the use of borax and salt in a zinc alloy, he admitted the work might be done without; it was largely a question of custom and personal preference. Ground fluor-spar and glass were both good in their way. The final remark in regard to cool metal and feeding was quite correct, as it was, of course, necessary to keep it up to the temperature which would allow proper feeding; but as a general rule, large castings could be poured with cooler metal than small, thin work. It was a matter in which common sense had to be exercised.

Mr. J. Oswald (Branch President), in proposing a hearty vote of thanks to the lecturer for his address—a motion which was unanimously carried—announced that on March 16 next, a visit for the members had been arranged to the works of Messrs. George Kent, Limited, at Luton, and that the management had kindly promised to keep the works in operation during the afternoon in question, for the additional interest of the visitors.

## The Rover Works, Coventry.

On Monday, February 5, a party of members of the Birmingham Branch of the British Foundrymen's Association visited the works of the Rover Company, Limited, at Coventry. Every facility was given for gaining an insight into the firm's methods, and at the conclusion special acknowledgement was made of the frankness and thoroughness with which all inquiries were met. The Works employ during the busy season some 2,200 hands, an unusually small proportion of which number is made up of women and girls, these being employed only in the nickel-plating shop.

The foundry, appropriately enough, was the first department visited. Some time was spent here, and the work of the department was explained by Mr. F. H. Hurren, the foundry manager (who is a member of the Association), and by other members of the foundry and pattern-shop staffs. The main shop is 60 ft. by 40 ft., and has two extensions, one 50 ft. by 18 ft., and the other 45 ft. by 18 ft., the old part and the extensions being thrown into one. There is also a new foundry opening out from the old one. This is 72 ft. by 20 ft., and is devoted chiefly to cylinder and piston work. Castings are required from the foundry in cast-iron, malleable cast-iron, aluminium, brass and gunmetal, and the Rover Works enjoy a rare distinction of having all the castings used made on the premises. The largest iron casting is the car flywheel, weighing, as a rule, about 121 lbs. The largest made in aluminium is a crank-case, weighing 62 lbs. The melting appliances include a 2-ton Evans drop-bottom cupola, for grey iron, six pot furnaces for aluminium and brass, and seven pot furnaces for malleable cast iron. During the busy part of the season a Meyer air furnace is used for melting aluminium.

Although a good deal of repetition work is done, moulding machines are not employed as yet to the extent one would expect. The foundry, however, uses one Britannia machine, two Bonnvillain (French) machines, and two table moulding machines. The two French machines are worked by hand power, and the two table machines by compressed air. The iron castings comprise, among other things, flywheels, clutch parts, brake shoes, and brake rings; the aluminium work includes crank cases, gear boxes, dash-boards, motor-cycle crank cases, and small motor-cycle parts generally; and the gunmetal work comprises nearly all the small parts, including the bushes and carburetters. Among the brass castings are the motor-cycle cylinder patterns and crank cases. For the brake parts, control parts, hubs, and worm cases, malleable cast iron is largely used. In moulding for motor-car and cycle cylinders, Mansfield sand is used, and for brasswork generally the fine yellow Failsworth sand. For other work of the foundry the ordinary Birmingham red sand is mostly used. The daily melt runs from 2 tons to 2½ tons of grey iron, about 4½ tons of malleable iron, from 2½ tons to 3 tons of aluminium alloys, and about 25 cwt. of gunmetal and brass. The cylinders, including motor-cycle cylinders, turned out every week, number about 160. About 150 men are employed in the foundry. The casting of the cylinders for motor cars and motor cycles is, of course, one of the most important sections of the foundry work, the great difficulty being to produce a sound boss. The visitors were particularly interested in the brass patterns used in cylinder moulding. Four large annealing ovens are included in the foundry equipment.

In the spacious tool shop the visitors were particularly interested in the excellent jig work done there, as well as in the various special tools, gauges, etc., and the specially designed automatic machine tools. On the left of this section was seen the crank or gear department, where all parts belonging to the gearing of a bicycle undergo the various operations necessary to make them absolutely interchangeable with each other. At the end of this section are two Crossley gas engines, each of them capable of developing 80 h.p. Farther on is a continuation of the machining department, occupied on the right hand in the manufacture of pedals and brake work, and on the left with the lugs, bottom bracket, milling, profiling, etc. Farther on was seen the hub section. The machinery in this is driven by a large electric motor.

The frame and fork building department was found particularly interesting on account of the great care exercised in the building up of each of these parts in jigs or frames. Near at hand is the wheel-building section, where the hubs, spokes, and rims are brought together. Here also are two large gas engines, driving the spindles for rough grinding, smoothing, and plate-polishing, according to the class of work to be done. The polishing shop is shut off entirely from the rest of the building in order to prevent the dust from penetrating to any other part of the factory. Beyond this are the hardening furnaces, the blast for which is produced by a large electric motor.

The Rover museum contains a number of old weather-worn cycles, including that belonging to Mr. Ebenezer Walton, of the Black Watch, who rode over 70,000 miles in five years on solid tyres.

The operations pertaining specially to the manufacture of motor cars and motor cycles are carried on in a new factory, specially equipped for the purpose. The whole establishment is heated and ventilated by special plant driven by electricity. Immediately outside the factory is a large room, reserved as a mess for the men, and there is evidence that the comfort and well-being of the workpeople are studied in every particular by the firm.

# Moulding an Internal Flange Cylinder in Loam.

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In the following description of the moulding of an internal flange cylinder, to some there may be nothing new, but to others who have not had the opportunity of coming into touch with this class of work, the description may be interesting, and perhaps instructive. As details in moulding operations

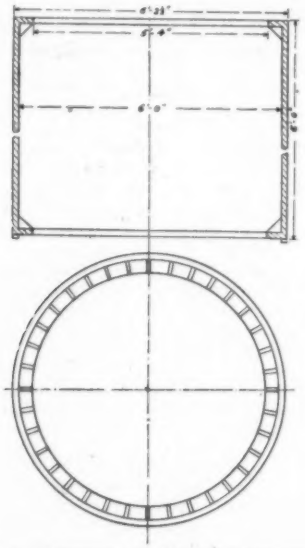

FIG. 1.—SECTION AND PLAN OF INTERNAL FLANGE CYLINDER.

are important, it is the intention of the writer to work to definite dimensions. Accordingly, the description of all tackle made will be to suit the dimen-

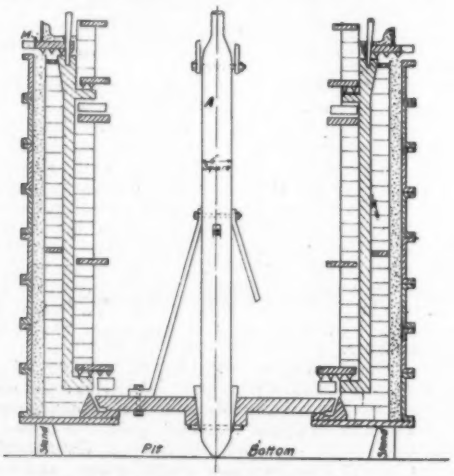


FIG. 2.—VIEW OF ASSEMBLED MOULD

sions of cylinder given. The usual contractions in all cases must be allowed.

The cylinder under consideration is 6 ft. in diameter by 6 ft. deep and 1¼ in. thick. The internal flanges are 4 in. across the face by 1½ in. thick, with 36 brackets, as indicated in Fig. 1.

This cylinder could be made on the floor level with vertical binder close to the outside brickwork, but it is more convenient to make it in a pit and ram the brickwork with rings when such are available. A

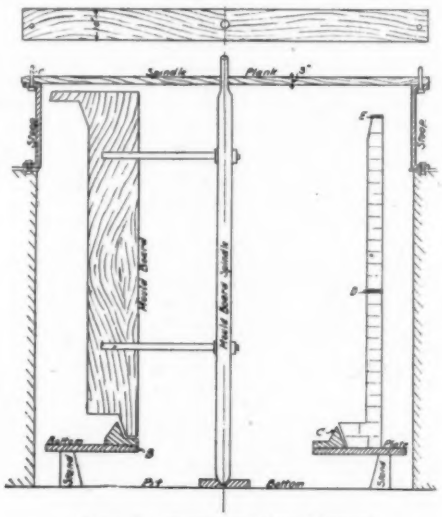


FIG. 3.—BUILDING THE MOULD.

bottom plate (Fig. 13) is levelled at a convenient height from the pit bottom (see Fig. 3), so that the top of the cylinder is 3 ft. or 4 ft. above the top

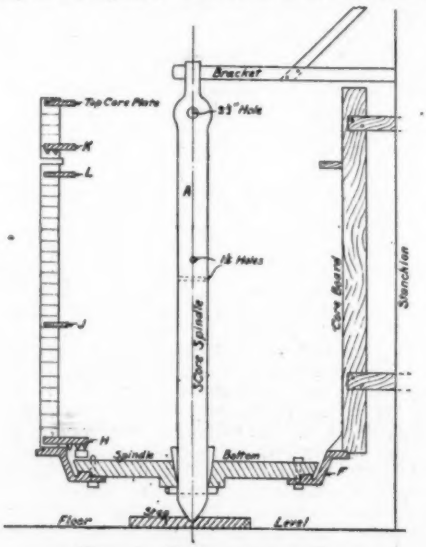


FIG. 4.—BUILDING THE CORE.

of the pit, which renders it convenient for casting. Provision is made from the underside of the bottom

plate, or lower down, for the rail, bar, or step, to carry the spindle, which should have a V-shape centre corresponding with the bottom of the mould-board spindle.

The top end of the spindle is round (3 in. diameter) for about 12 in. down, and 3 in. square for the arms. The top of the spindle should always be arranged to come rather higher than the top of the stoops on the pit side. These have pins to fit pinholes in the ends of the spindle plank, which gives trueness and rigidness to both plank and spindle—an absolutely necessary feature for exact working. In building up, red radius bricks will be found more economical than the ordinary 9 in. × 4 in. × 3 in. bricks.

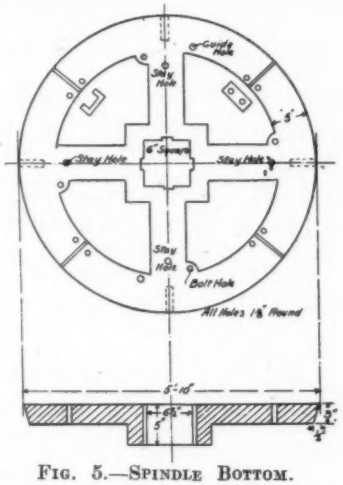


FIG. 5.—SPINDLE BOTTOM.

Fig. 2 shows a sectional view of the assembled tackle, and part of the mould and core; Fig. 3 a sectional view of the mould brickwork, spindle, striking board, stoops, plank, etc.; and Fig. 4 a sectional view of the core brickwork, core-board, core-dish, bracket, spindle, etc.

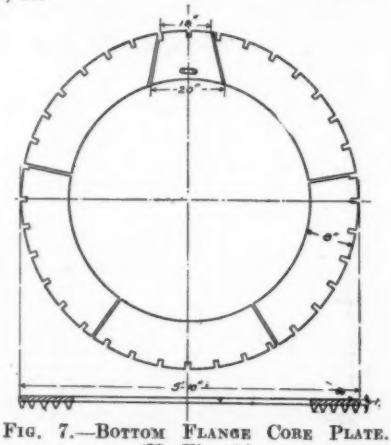


FIG. 7.—BOTTOM FLANGE CORE PLATE. (H, Fig. 4.)

### Building the Mould.

Referring now to Fig. 3, when the spindle centre step, bottom plate B (see also Fig. 13) and core seat C (Fig. 15) are levelled in the pit, the mould board is bolted to the arms, and set with size stick to give the external diameter of the mould. The spindle with the boards is lowered into position, the plank passed over the top and pinned in position. There should be no play in the pinholes of the plank, nor in the middle hole for spindle, just sufficient freedom for the spindle to revolve being allowed. The striking board is lowered to within 2 in. of the bottom of the core seat, to the bottom plate; that will be an allowance for packing, wedging, and centreing the core when assembling.

Bricking is now commenced. When half-way up, a binder D (shown in detail in Fig. 12) is put on to stay the brickwork. When bricked to the top, as will be noticed the head is enlarged; another binder

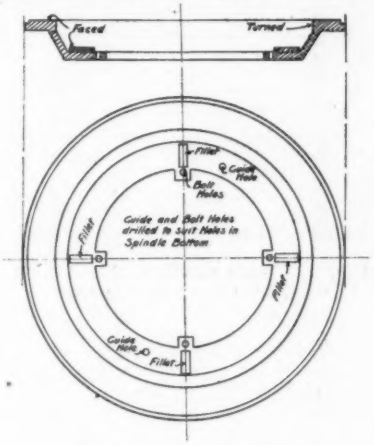


FIG. 6.—CORE DISH.

E (see Fig. 14) is put on, allowing ½ in. of loam between it and the top finger on the board for striking up. The wall will now be secure. The spindle

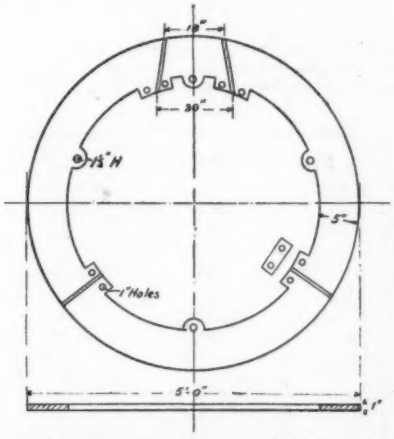


FIG. 8.—CORE BINDER. (J, Fig. 4.)

and board are taken out and the brickwork dried with a pan fire in the pit, after which the spindle and board are replaced, and the wall is roughed up while warm, and the mould struck up with finishing loam. The pan fire is again requisitioned, and when the mould is dry it is tried by size stick, dressed and blacked. After ramming the rings around the brickwork (see Fig. 2) with black floor sand, for which 2 to 3-in. allowance should be made, the mould will be permanent, and a large number of castings may be made in it without disturbing the brickwork.

### Building the Core.

This is illustrated in Fig. 4. The core dish F (see Fig. 6) is levelled, the inside oiled, and parting sand thrown on, and a thickness of stiff loam carried round. The core spindle with bottom G (see Fig. 5) which forms the core seat, is lowered into the dish F, guide pins and holes for same having been provided, and beds itself into the stiff loam, resting upon the facing pieces or packing, which ensures it being level in the dish bottom. The dish is then bolted to the spindle bottom, and the spindle is set on the step, as shown in Fig. 4, and secured at the top of bracket. The core board, fixed to the stanchion, is then set

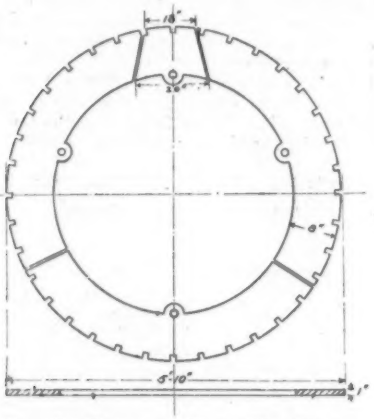


FIG. 9.—PLATE TO CARRY TOP FLANGE, WITH RECESSES FOR BRACKETS.

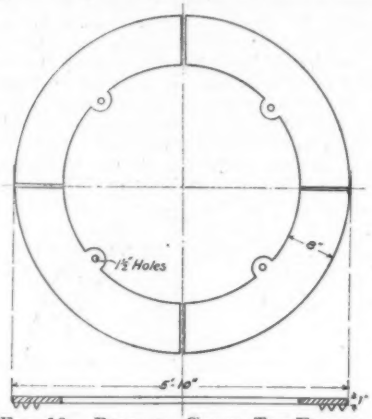


FIG. 10.—PLATE TO COVER TOP FLANGE. (L, Fig. 4.)

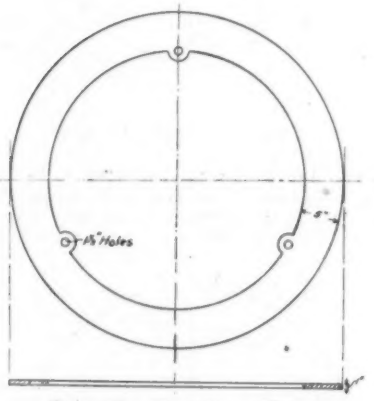


FIG. 11.—TOP CORE PLATE.

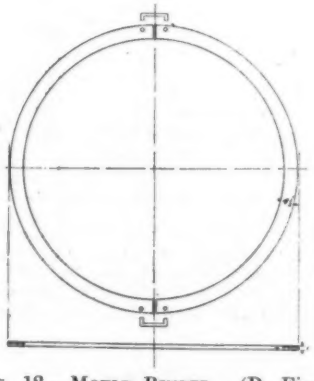

FIG. 12.—MOULD BINDER. (D, Fig. 3.)

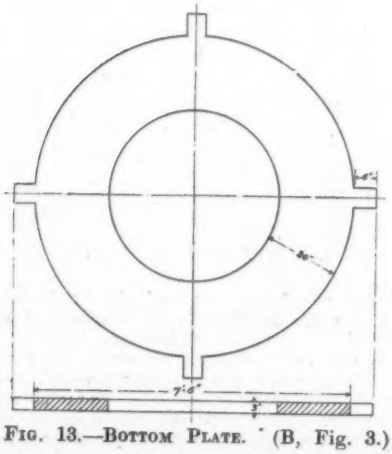


FIG. 13.—BOTTOM PLATE. (B, Fig. 3.)

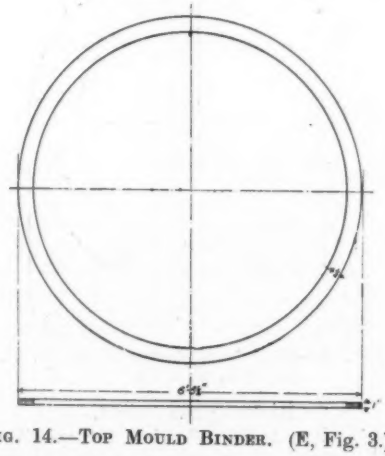

FIG. 14.—TOP MOULD BINDER. (E, Fig. 3.)

to size sticks, and the spindle and dish revolve together to ensure trueness of the core board, which is stationary.

The first course of brickwork comes about level with the flange of the dish, which forms the top face of the bottom flange. A thickness of stiff loam is laid on this course of bricks and the flange of the dish, previous to which the small brackets are placed in position; the circle of prodded segments H (see also Fig. 7) is laid around on the stiff loam; this carries the upper surface of the flange and brickwork for the core. One binder J (Fig. 8) should be

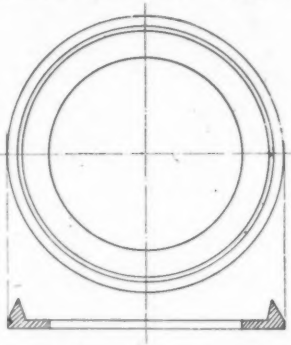

FIG. 15.—CORE SEAT. (C, Fig. 3.)

built in this length of core to give the core stability and to resist pressure.

The finger on the core board forms the top flange, which has a carrying plate, top and bottom, K and L (Figs. 9 and 10). When the core is bricked up, it is roughed with loam, well stiffened, before striking with finishing loam. After trying with the callipers the core board is released, and the core, with the dish, is lifted bodily to the stove carriage and dried; afterwards the bolts or cotters holding the dish to

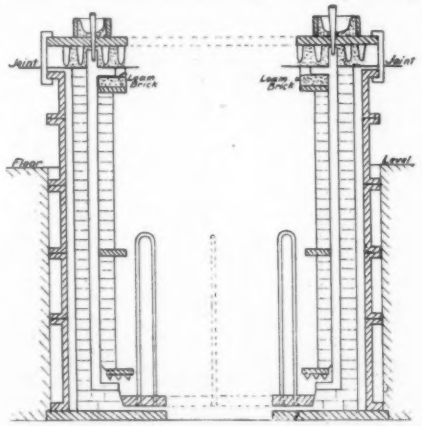


FIG. 17.—SECTION SHOWING ALTERNATIVE METHOD.

the spindle bottom are released, the core lifted out of the dish, rested, and tried with the callipers; the small brackets are plumbed to the top of the brackets, marked off and cut out, the bottom brackets drawn out, and the core is dressed and blacked ready for the mould.

### The Tackle.

*The Core Spindle*, shown at A, Figs. 2 and 4, is 6 in. square, 8 ft. long over all, with wrought iron 2½ in. diameter cast in for the journal. Holes, 1 in. diameter for the stays, and one 2½ in. diameter for the shackle bolt, are cast in.

*The Spindle Bottom*, Fig. 5, is 3 in. thick, and deeper at the square boss, and is cast open sand. It is cut through the rim in four places to prevent fracture, due to varying temperatures, and the places cut through are bolted with plates or cramped as shown. Provision must be made for guide holes and bolt holes for core dish, and these may be 1⅛ in. round.

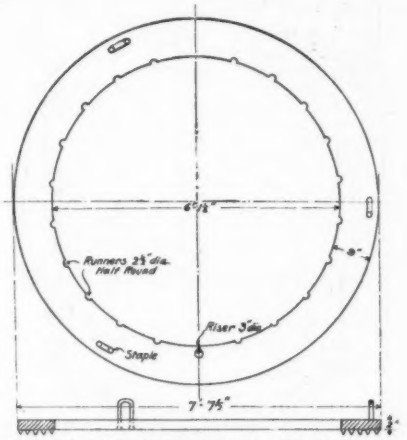


FIG. 16.—TOP CAKE PLATE. (M, Fig. 2.)

*The Core Dish*, Fig. 6, is made in loam, faced on the top, and recessed for small loose bracket patterns.

*Prodded Segments*, Fig. 7, form a plate which covers the dish flange. This plate is made in one ring with recesses for small brackets. The divisions are cut through with flat cores, and a staple is cast on the key piece for lifting out when easing for contraction.

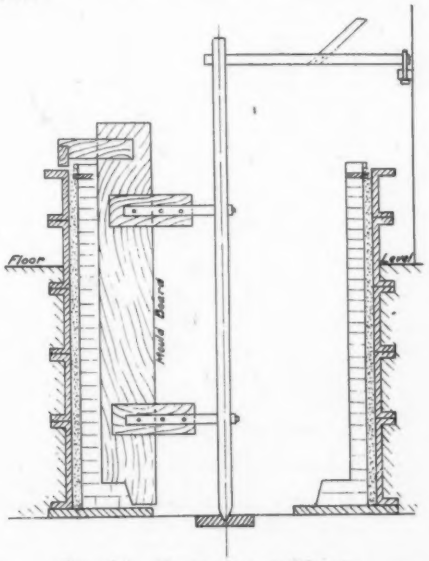


FIG. 18.—BUILDING THE MOULD.

*The Core Seat*, Fig. 15, is made open sand, with an allowance of ¾ in. of loam on seat.

*The Core Binder*, Fig. 8, is cast in one ring, and the divisions are partly cut through with flat cores, the rest being broken with ease when required.

*The Plate to carry Top Flange*, Fig. 9, is made the same as the binder, but is wider, and recessed for small brackets.

*The Plate to cover Top Flange*, Fig. 10, is cut in four equal divisions, and is roughed on the underside to hold the loam, when roughing and striking up the core.

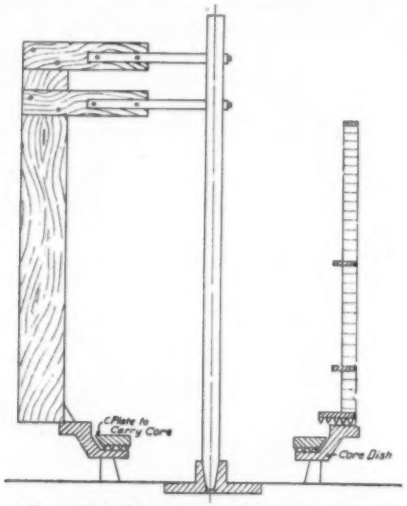


FIG. 19.—METHOD OF MOULDING WITH STATIONARY CORE DISH.

*The Top Plate*, Fig. 11, is cast in one ring, with three holes for lifting purposes; from this plate the core is packed down.

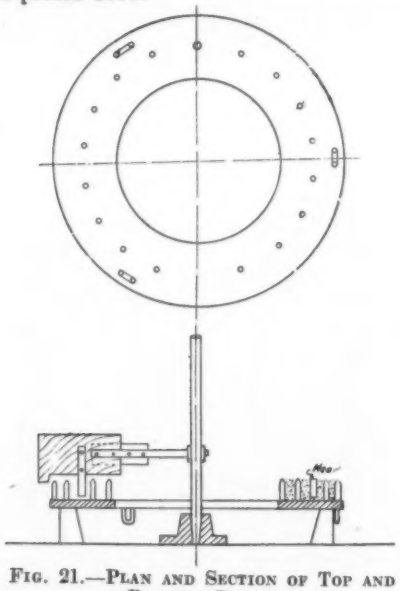

FIG. 21.—PLAN AND SECTION OF TOP AND RUNNER PLATE.

It will be noticed that the core-binder plates to carry and cover the flanges have a wedge-shape segment, called a key; these must align when building the core, as they have to be detached with the brickwork to allow for contraction of the cylinder after casting. It will also be noticed that provision is made with the core binder, Fig. 8, for bolting together the segments; this saves making a new binder for every cylinder, as they are simply fastened together as the next core is being built.

*The Mould Binder*, Fig. 12, is cut in halves, and requires little holding together, which is done by a small cramp, when building the mould, holes being cast in the ring at fixed centres. The top binder of the mould, Fig. 14, is a plain round ring, which keeps the brickwork intact.

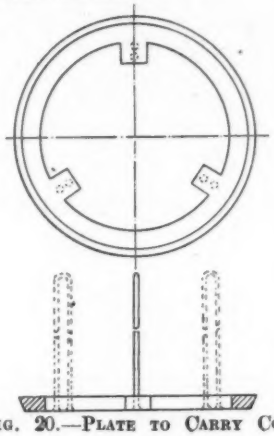

FIG. 20.—PLATE TO CARRY CORE.

*The Top Cake Plate*, Fig. 16 (shown at M in Fig. 2), which closes in the mould, is prodded, and has 2½-in. half-round holes cast in for runners, and a 3-in. hole for the riser. Flat runners 1 in. by ½ in. are most suitable for flange cylinders. The core and cake plate can be held down by cramps, a cross or beam with four bearings, and fastened with slings from the handles of the bottom plate, or cramped to the outside rings. There are other ways of holding down, but probably the ways just named are as simple as any.

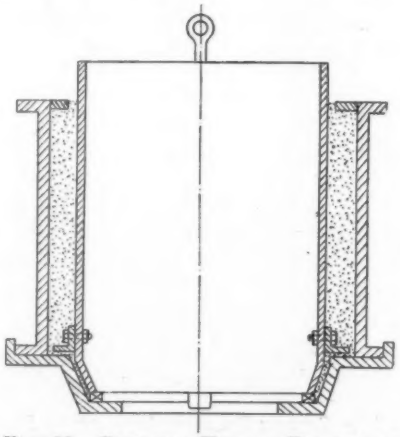

FIG. 22.—SECTIONAL VIEW OF TACKLE FOR SAND CORE OF CYLINDER.

The faster these castings can be poured the better. Care must be taken that the accumulation of scum in the runner does not get into the casting.

Should cores be required cast in the flanges, the main core would be struck level with the top flange; then a separate length of core above the flange should be made. Prints would be required in the dish for the bottom flange, and a full template made for the top flange.

Collapsible core barrels are sometimes used for internal flange cylinders, but it is questionable, all things considered, if there is any great economy in their use as compared with a bricked core.

Fig. 17 shows a sectional view of an alternative way of moulding these cylinders. A hole is dug in the foundry floor, the bottom plate, spindle step or cross levelled, and after the mould walls are built, some kind of casing, or rings, are rammed around the brickwork, and the hole filled up to the floor level

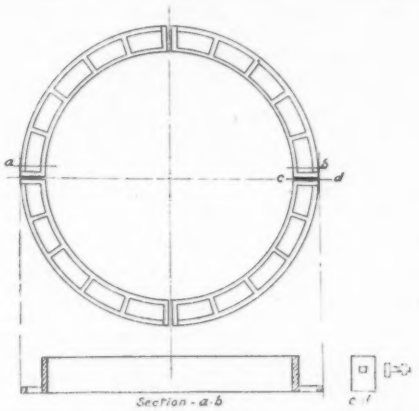


FIG. 23.—PLAN AND SECTION OF GRIDS.

(see Fig. 18). A core dish is used by this method as before, but no core spindle with fixed bottom for carrying the core. The core dish in this case is stationary, the core board revolving on and around the dish with the core-board spindle in an ordinary spindle cross. Core binders are used as before. The plate which carries the core, a plan view of which is seen in Fig. 20, is roughed at the bottom and

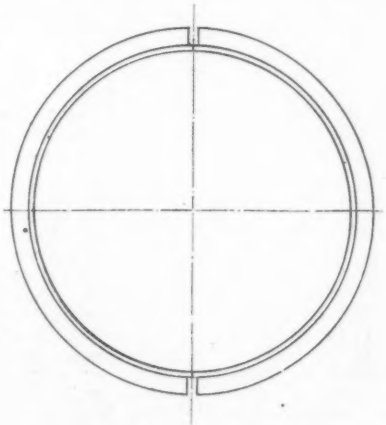

FIG. 25.—BOTTOM OR TOP VIEW OF CORE BOX

bedded onto stiff loam. When bricked, struck up and stiffened, this is lifted out of the dish of green sand and stoved. The dish is not moved at any time. It will be noticed in this way the top flange is not bricked into the core, as in the former method, but struck off level with the flange. This is convenient if cores are required cast in the flange. The core is lifted by three staples, as shown.

Fig. 21 shows plan and section of the top and runner plate, which has the head struck up in it, the finger on the board as shown forming the head, which is a continuation above the top flange. A guide must be struck on this part, as also on the mould to ensure trueness.

Figs. 22 to 26 show a method of making cores for internal flange cylinders in sand from an iron core box. The preparation and layout for this method is

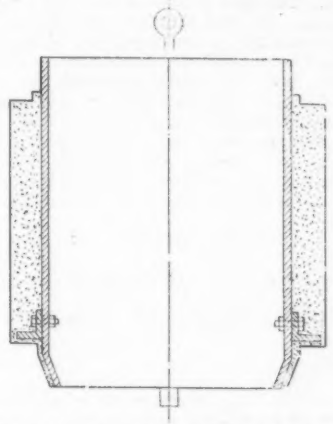

FIG. 24.—SAND CORE WHEN REMOVED FROM BOX.

expensive, and it is only adopted when an order is sufficiently large to justify the outlay, or where several cylinders are required to be cast each day. The sketches are practically self-explanatory.

The dish for the core seat and bottom flange is similar to that already described, except that it must have guides cast on to receive the iron core box, which is in halves, bored, and all joints faced.

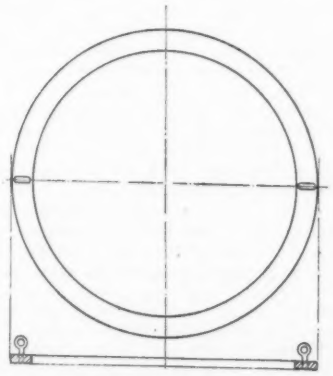

FIG. 26.—TOP FLANGE.

Ordinary core barrels are used, of the right length and diameter, with slot holes cut near the bottom for passing the tee-head bolts through for fastening the grates to carry the sand. The circular grates are made in convenient length segments to suit the radius of the barrel, with lugs cast on with slot holes for bolting to the barrel. A loose flange of the same internal diameter as the core box, with brackets cast on (if required), is bedded and rammed level with the top of the core box, to form the top internal flange.

Proceeding to make the core, the dish is levelled anywhere within reach of the crane and stove floor. A thickness of stiff loam, or well-ground sand, is carried around the taper part of the dish; the seat of the band, which is slightly prodded for adhering, is claywashed and lowered into position, bedding itself into the seat, and on three packings between the dish and the end of the barrel to take its weight. A course of sand is then rammed, and the grids, after being claywashed, are bedded, tucked and bolted to the barrel. The two halves of the core box are now put onto the dish, and the joints cramped. Ramming proceeds to the top, when the loose flange is bedded level with the top of the core box. After being drawn, the core box is liberated and the core lifted from the dish, finished off, blacked, and stoved.

After the cylinder is cast, the bolts and nuts holding the grids to the barrel are released; the bolt is given a half turn and drawn inwards; the barrel is drawn, thus setting at liberty the whole of the inside so that contraction can take place.

## A Practical and Rapid Test for Adulterations in Core Oils.

While core-making by ramming a mixture of sand and binder in a core-box and then baking the core is still generally practised, for small cores a radically different process is frequently used, particularly in America. A kind of quicksand is prepared by intimately mixing, in a suitable machine, sharp-sand and some vegetable oil (preferably linseed oil) in the proportion of from 30 to 100 parts of sand to one part of oil. The mixture, being mobile, is poured into the core-box to well fill the latter, and the excess is simply scraped off with a straight-edge drawn across the top of the box. Provision is made for taking apart the latter and leaving the fragile core on an iron plate on which it can be transported to the core-oven without injury. These oil-cores are extraordinarily tough when baked, and are impervious to moisture. They require no venting, as but little tendency to form gas is manifested on pouring the metal.

Owing to the high price of linseed oil during the last few years, however, "Soya" oil, pressed from that Chinese bean, has been introduced and found an excellent substitute. The very best substitute for linseed oil is, however, said to be crude whale oil, which costs about the same as "Soya" oil, although its use is objected to on account of the unpleasant odour emanating from the core-ovens during the operation of baking. Cotton-seed oil has been used, but, as a large proportion of oil to sand is required, no economy results.

The high cost of the fine grades of these vegetable oils has brought about the introduction of so-called core-oils. These usually consist of linseed oil as a base and mineral or resin oil, or both. Experience has shown that the presence of the latter non-drying oils materially affects the cores, renders them brittle and subject to rapid deterioration, and is, therefore, undesirable. Hitherto, however, no method except the costly one of chemical analysis, usually impracticable in industrial plants, has been available for detecting their presence and amount in such oils. Before the Metallurgical Section of the Franklin Institute, however, Mr. A. E. Outerbridge, Junr., described a new test for use in cases where chemical analysis is not available.

The basis of the method is that hydrocarbon oils (incorrectly termed "mineral") and resin oils exhibit, under the rays of reflected light, the phenomenon known as fluorescence and termed in this connection "bloom," while vegetable oils exhibit no such fluorescence or "bloom." All these oils appear of their natural colour in transmitted light. In both mineral and resin oils the degree or intensity of bloom depends on the degree of refinement of the oil, and is generally in proportion to its natural colour. Mineral oil exhibits, however, green fluorescence, while that exhibited by resin oil is blue.

Fluorescence is the property inherent in certain substances of becoming self-luminous on exposure to "ultra-violet" or "actinic" rays of light. Such rays are present to some extent in daylight, and under this the phenomenon can be observed to a certain degree. As the result of investigation using the various forms of electric light, such as that given by carbon or tungsten filament lamps, by Cooper-Hewitt mercury vapour tubes, by ordinary and flaming arcs and by enclosed arcs, it was found that the intensity of bloom in bloom oils was particularly increased under the rays of the latter.

That the method of detecting adulteration is efficient so far as discrimination between nature of oils is concerned is shown by the fact that under the rays of the enclosed arc none of the vegetable oils show the slightest trace of fluorescence. On the other hand, all mineral and resin oils, except the very volatile products of petroleum, such as gasoline and petroleum ether, show marked bloom, as also do samples of so-called No. 1 and No. 2 lard oils, while pure white strained lard oil is seen to be free from bloom.

Processes of chemical treatment are supposed to have been discovered to "de-bloom" mineral and resin oils, thus facilitating their use as adulterants of the more expensive vegetable oils. Samples of de-bloomed oils of various grades and colours were obtained. Such exhibited no fluorescence in bright sunlight or in the light from the ordinary arc. On exposure to the rays from the enclosed arc they are, however, seen to possess distinct bloom. Any kind of mineral or resin oil can be distinguished from any kind of vegetable or animal oil. Further, if the latter oils be adulterated with the most minute quantity of the former, the impurity can at once be detected by the method, and in many cases the nature of the adulterant can be at once stated. The quantity of adulteration present is determined from the intensity of bloom produced in oils free from bloom; the nature of the impurity from the green or blue colour.

By preparing a set of standards of pure linseed oil with one-tenth, one, two, three, four, etc., per cent. adulteration with mineral or resin oil, in glass test-tubes mounted in a suitable frame against a dark background, a means is provided whereby the proportion of impurity in any adulterated linseed oil can be quickly determined by colour comparison on exposure to the enclosed arc Such standards furnish a "scale of fluorescence" somewhat similar to the well-known carbon colour-scale used in steel foundry laboratories for rapidly determining by colour comparison the proportion of carbon in an acid solution of steel. These standards, having linseed oil as a base, may be used for the examination of any adulterated vegetable oil, but for lard oil a special set of standards with pure lard oil as a base must be made up.

In cases where the adulteration of vegetable oils exceeds 10 per cent., it is necessary, in order to correctly estimate the exact amount of it, to dilute the sample with a known quantity of the pure oil, quantitatively determine the adulteration in this diluted oil, and thus in the original sample by calculation.

# British Foundrymen's Association.

## Formation of Newcastle-on-Tyne Branch.

A meeting was held on Saturday, February 3, at the County Hotel, Newcastle-upon-Tyne, for the purpose of forming a local Branch of the British Foundrymen's Association. The chair was taken by Mr. R. Wallis, of the Wallsend Slipway and Engineering Company.

### Address on Foundry Practice.

At the commencement of the meeting, some very interesting facts were given by Mr. R. Buchanan, F.R.S.A., a Past-President of the Association, on "The Melting and Cooling of Iron." Mr. Buchanan said that he simply wished to bring to their notice some facts which he hoped would lead to a good discussion afterwards. Touching on the genesis of the furnace in which they were all in the habit of melting iron, the earliest known furnace was certainly in use as early as the year 1,293. That furnace varied in size, but it was in some cases as small as 2 ft. 6½ in.; about 2 ft. wide at the top, and, say, about 14 in. at the bottom. Much later than that period, as a matter of fact about the 16th century, instead of bellows there was used what was called a "trunk," which was a hollowed-out tree with slots in it. Small streams of water were made to run down this hollow tree, but not filling the whole diameter of the tree. This drew in air, and that air not being allowed to escape in any other way was used to blow the furnace. It would naturally be understood that a blast so obtained must necessarily have been charged with moisture. Still it was effective, and, as regards the steel they were able to make, this had never been surpassed, even with the most modern scientific appliances.

Dealing with melting points, Mr. Buchanan said that in iron, the manganese, which was an important constituent, did not exist as a separate compound, but was always allied with something else, and although one spoke of sulphur, phosphorus, silicon, manganese, and so on, actually all these constituents were existing in combination with others. The first to melt, when melting took place, was a phosphorus compound, which melted when the iron was still apparently in the solid condition. The next to melt was the silicon compound. Silicon, as they knew, was a very important element, because it largely controlled the condition which the carbon was going to exist in when the casting was cool, and according to the amount of silicon present, so would the condition of the carbon be in the resulting casting. After that the next to melt was the carbide of iron. Silicon had the function of throwing the carbon into the graphitic form, and if a soft casting was desired, the silicon should be up to a certain percentage, so that it might control how much of the carbon would become graphitic and how much left dissolved as combined carbon. The weight of the casting would be a guide as to the amount of silicon required. Time and silicon were interchangeable terms. With a light casting cooled rapidly through the temperature at which the graphite alone could come out, and with a low percentage of silicon present, the graphite would not come out at all. So that with quick cooling more silicon was required than with slow cooling to get an equal condition of the crystals. This was where he thought test bars often failed; foundrymen were too afraid of low silicon iron when making test bars.

Coming to the cooling of the iron, he hardly thought it necessary to mention the necessity of melting and casting the metal hot. One advantage of melting hot was the silicon was more active in taking up sulphur from the iron, and at the same time when the iron was properly fluid it also gave the silicon a good chance to rise and be skimmed off.

He was sometimes met with the remark that such and such an iron was a "dirty" iron, and it had always appeared to him a doubtful point as to what a foundryman meant when he talked of "dirt." It was rather a general term, and might mean either sand or slag, or it might be carbon or kish. He often discovered founders mixing up the idea of slag and carbon, and, sometimes, unless the slag was there in considerable quantities, they were not quite sure which was which. He was afraid there was a good deal more "dirt" in the shape of kish than was generally suspected, and that was obtained by using too much coke in the cupola. Molten iron would take up a large amount of graphite if it was available, according to the temperature to which the metal was raised. If a lot of carbon were dissolved in the metal it would be found to come back somehow, and very often it came back where, and in a condition in which it was not wanted. When that temperature of the metal fell a number of degrees, and even before casting in many cases, the metal began to give out some of the graphite which had been dissolved in it. Not only that, but the very act of pouring the metal into the mould, and the jumbling of the metal in the pouring, assisted this separation of the graphite, and if it was not found running to a definite place, it was very often found where there were large surfaces, and usually at the top of the mould. The cure for that was either using less coke, more blast, or more scrap, otherwise diluting the metal to a further degree, so that there would not be such an amount of carbon present to come out before the metal was in its place.

Sometimes foundrymen and others spoke of oxides in the metal. He did not believe that any grey irons contained free oxides. They were present in malleable iron, and in steel before the addition of ferro-manganese, but not in grey iron. It was also a common belief amongst some practical foundrymen that No. 1 iron was stronger than the higher numbers such as No. 4. He thought that belief was based on the assumption that because No. 1 was a bit dearer than No. 3, whenever strength was wanted No. 1 should be used. The modern foundryman did not believe this, but there was still a good sprinkling of foundrymen about who did.

### Discussion.

Mr. Gallon said Mr. Buchanan had greatly interested him. With regard to "dirt," he had had to deal with this himself, and he was under the impression that the dirty iron had been mostly Scotch iron. But he found from Mr. Buchanan's remarks that he was wrong, that it was really not dirty iron, but iron highly charged with silicon, and also that he had been putting insufficient scrap into his iron. He would like to know whether hot iron could be got with a large percentage of coke, because in his experience he had found that if a very large percentage of coke were used, not hot iron, but sometimes cool iron, was obtained.

Mr. Paulin remarked that this matter of silicon seemed to be one from which many wide deductions

could be drawn. For instance, it had been said that if it were desired to get a solid casting, a certain high percentage of silicon would be necessary, and yet he had known castings not more than 3 in. square in section, with sponginess, which he imagined was largely due to the higher silicon, since the use of a pig-iron with lower silicon caused the trouble to disappear. It might be deduced from Mr. Buchanan's remarks that a No. 4 pig was really stronger than No. 1; but a No. 4 was broken more easily. Mr. Buchanan had referred to the marked influence that different pressures of blast had on the resulting metal. He (the speaker) had found that to follow out the lines generally laid down by most of the American writers, to treat the cupola to a continuous blast—a large volume of air—what they called a sympathetic blast—generally gave a very cool iron, and he was never sure that it was uniform, while altogether it was not a good iron for ordinary engineering purposes. It looked to him as if a fiercer, more concentrated blast generally produced a much more liquid iron in quicker time, and gave an altogether cleaner casting. One gentleman had asked about the temperature of pouring. That was a very important thing. Mr. Buchanan had laid great stress on the fact that the iron should be poured hot, yet it was well-known that in a good many cases to pour hot would be most destructive to the mould. There must be a certain amount of discretion used as to how far they were to allow the metal to cool down before putting it into any very large mould.

Mr. Henderson suggested that it would be an advantage always to have the small test bar. He understood that a small test bar which was cast in a small section would be relatively stronger than a bar cast in a large section.

The Chairman said Mr. Buchanan had remarked that there were no free oxides in ordinary grey iron. He should like to ask whether, in his opinion, there were any nitrates. Finally, he would like the foundrymen not to lay too much stress upon what Mr. Buchanan had said in regard to hard castings. He thought the engineers and the foundrymen ought to work hand in hand.

Mr. Buchanan, replying, said that as regards what Mr. Gallon had said about dirty iron, he thought they might take what he (Mr. Buchanan) had said as correct—that dirt was either silicon, kish, or carbon, or sand which had got adrift, and the cure was, as he had said, either further additions of scrap reducing the coke in the cupola, or increasing the blast. With regard to the question as to whether they could get hot iron with a large percentage of coke, he thought this was undoubtedly the case. As to No. 1 being more difficult to break than No. 4, he would like to see it. If they were out of the same casting it would be most interesting. If they were out of different castings, it was quite understandable.

### Formation of Branch and Election of Officers.

The General Secretary (Mr. J. E. H. Allbut) said it had been suggested that a Newcastle Branch of the Association should be formed, and he hoped the meeting would agree that this should be done. Although so many engineering and metallurgical societies existed, they did not find many papers appertaining to foundrymen and foundry matters given and discussed. It should be remembered that without the foundry the engineering side would not be able to stand. It was noticeable to-day that the foundrymen were occupying better places in the engineering world. The castings required were far more intricate than before, and it was usual now for the engineer to consult the foundryman about design. He would very much like to see a Newcastle Branch of the Association formed.

Mr. Henderson proposed, and Mr. Horsley seconded, that a Branch of the British Foundrymen's Association be formed.

Mr. Gallon supported the motion, which was put to the meeting and carried unanimously.

Mr. R. Wallis was proposed, seconded, and duly elected to be the first President of the Branch, and Mr. J. M. Wear was elected as Vice-President.

The following gentlemen were elected to form a Committee, with power to add to their number:—Messrs. Edward Smith, C. W. Taylor, Moorhead, James Smith, T. P. Jones (Middlesbrough), Fargreave, Wear, Matthews, and Henderson. Mr. H. V. Rang, of 39, Albury Park Road, Tynemouth, was elected as Hon. Secretary of the Branch.

### Future Arrangements.

Although this Branch of the Association is only a few weeks old, arrangements for the session have been made well in advance. On March 27, Mr. R. Wallis (Wallsend Engineering and Slipway Company) will deliver his presidential address in the Lecture Hall (Y.M.C.A. Buildings), Blackett Street, Newcastle. On April 25, a Paper will be read by Mr. J. Smith (South Shields) on "Modern Foundry Practice," illustrated by lantern slides; and in May a further lecture will be given by Mr. H. Pemberton (Midland Railway Company's Works, Derby). Already there has been quite an inflow of new members to the Branch, which promises to be a robust and prosperous one.

## The Growth of Cast Iron after Repeated Heatings.

On February 20, Professor H. C. H. Carpenter, M.A., Ph.D., delivered, before the Manchester Branch of the British Foundrymen's Association, a lecture on the above subject. This lecture, with the discussion before both the Manchester and London Branches, will be dealt with in our next issue.

## Shipbuilding Amalgamations.

Two important shipbuilding amalgamations have been announced, one being specially notable as marking the impending extension to the Clyde of the operations of the Belfast firm of Harland & Wolff, Limited. This firm propose to acquire the shipyard in Govan and the boiler and engineering shops in Lancefield Street, Glasgow, of the London and Glasgow Engineering and Iron Shipbuilding Company, Limited. The other change is the acquisition by Barclay, Curle & Company, Limited, shipbuilders, Whiteinch, of the shipyard and dry dock at Elderslie, owned by John Shearer & Sons, Limited. With regard to Messrs. Harland & Wolff's purchase, the circular issued by the directors of the London and Glasgow Company to the shareholders states that they have for some time considered that it would be in the interests of the shareholders to dispose of the undertaking, and that they have concluded an agreement with Messrs. Harland & Wolff, by which that firm agree to purchase the whole of the shares of the London and Glasgow Company at £9 3s. net for each £9 share fully paid up. The purchase is conditional on holders of a minimum of three-fourths of the total shares issued agreeing to sell their shares. The market price of the shares for some time past has been about £6 per £9 share fully paid. The directors, knowing the whole position, have no hesitation in recommending the acceptance of the offer. They will do so themselves, and shareholders representing more than half of the capital have already agreed. The business of John Shearer & Sons, Limited, acquired by Messrs. Barclay, Curle & Company, is also a very old one, having been founded in the middle of last century. A few years ago the firm got into financial difficulties, and it was resolved to go into voluntary liquidation, but the business has been carried on as a going concern all the time.

# The Rotary Fore-hearth.*

The addition of a fore-hearth to the foundry cupola has the advantage of giving better and cleaner iron than is produced in the cupola without fore-hearth—a cupola in which slag is liable to flow out of the spout with the metal. The rotary fore-hearth has all the advantages of the stationary fore-hearth, permitting the flow of liquid metal to be regulated and keeping the iron hot and free of slag. The iron can be poured out in a large stream instead of the thin stream as from the ordinary cupola.

The rotary fore-hearth consists of the collecting chamber proper and the spout, the latter serving also as a slag separator. Two tube-shaped forms connect the cupola and the hearth, one being attached to the cupola and reaching deep into the inside of the fore-hearth. This tube forms the real passage for the liquid metal, and is protected by a refractory brick lining. The other tube is attached to the fore-hearth, rotates on this first tube and acts as a trunnion for the fore-hearth. The tube on the opposite side of the hearth is also hollow, and is used by the operator to watch the progress of the melting. Through this tube the connection between hearth and cupola can be opened in case of obstruction. The outer tube on the cupola side of the fore-hearth rests in a framework which carries the apparatus for tipping or rotating the hearth; the hearth is

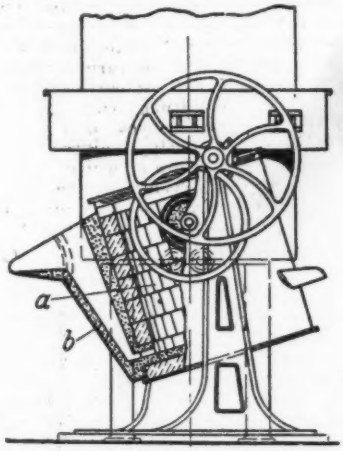


FIG. 1.—FRONT VIEW AND PART SECTION OF ROTARY FORE-HEARTH.

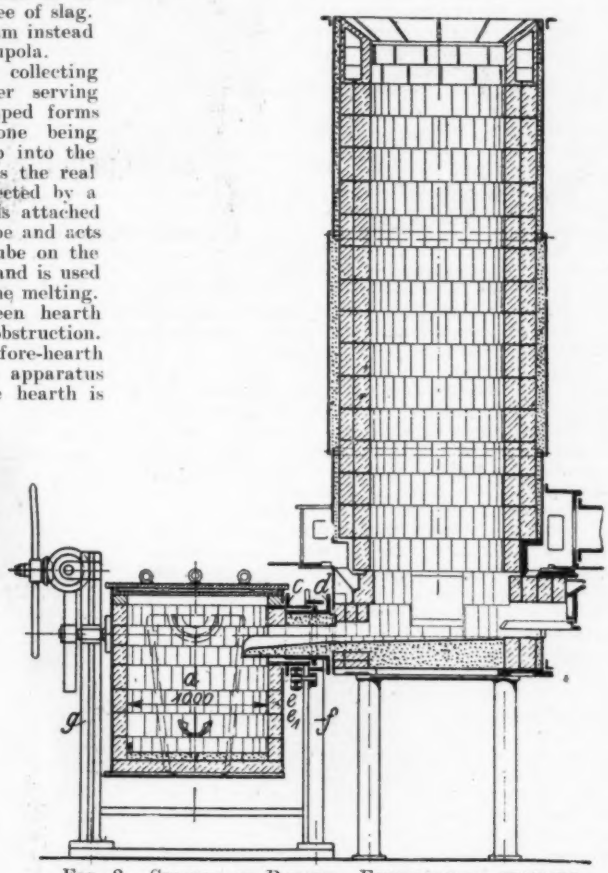


FIG. 2.—SECTION OF ROTARY FORE-HEARTH, SHOWING CONNECTION WITH CUPOLA.

easily rotated by means of a hand-wheel.

Figs. 1 and 2 show a rotary fore-hearth. The spout *b*, Fig. 1, is fastened to the fore-hearth *a*, which holds the metal as it comes from the cupola. The spout reaches down to the bottom of the fore-hearth and forms with the collecting chamber a sort of conduit through which the slag is separated from the liquid iron. With this arrangement it is impossible for any slag to reach the spout. The collecting chamber is lined with refractory material, but the spout is tamped and lined with green sand only. The latter is easily removed and renewed with little expense or trouble. Practical experience has shown that this lining is sufficient for about ten pouring operations. The hollow tubes *e*, Fig. 2, form a support for the lining of the fore-hearth at one end, and the other end rotates on the hollow tube *d*, which has a small projection, against which tube *e* abuts. The latter tube is supported in ball bearings on the framework *f* at the cupola side of the hearth, while the other side of the hearth is supported in the framework *g*. The tube attached to the fore-hearth, and resting on *g*, has a worm-wheel engaging a worm gearing. The tipping and rotating is effected by a hand-wheel working through two bevel gears.

When preparing the fore-hearth for service, the cover on top is taken off, and when returned is hermetically closed by means of a sand layer before beginning the melting operation. As soon as the air blast is turned on, the spout is closed up by a conical cast-iron plug, which is covered with a loam coating.

A recent departure from the usual construction is shown in Figs. 4 and 5. This new hearth is especially suited to foundries where large quantities of iron are poured at one time and where the fore-hearth could not be turned by hand, but would need electric or hydraulic power to rotate and tip it. Two cast-iron plates that serve as heads are attached

* From a Paper read by Th. Löhe before the German Foundrymen's Association at the Berlin Convention.

to the iron shell of the fore-hearth, as shown in Fig. 4. The outer edges of both side plates move respectively on two rollers fastened to cast-iron supports. The hand-wheel is fastened to a support beneath the hollow plate opposite the cupola, and by a simple gearing rotates the hearth. The spout is of the usual construction, and can be detached.

To prepare this hearth for work, the cover is raised, and a man descends into the hearth. When emptying, after pouring, it is rotated downward so that the cover faces the floor and the contents can be dumped out without any trouble. The slag is drawn through a slag tap hole on the side opposite to the spout.

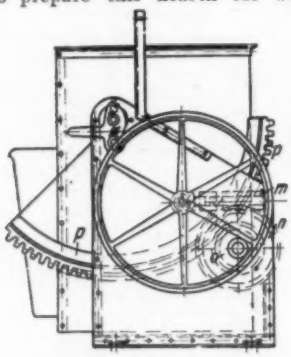

FIG. 3.—SIDE ELEVATION OF ANOTHER FORM OF ROTARY FORE-HEARTH.

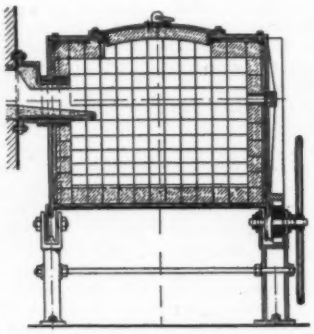

FIG. 4.—LONGITUDINAL SECTION OF LARGE ROTARY FORE-HEARTH.

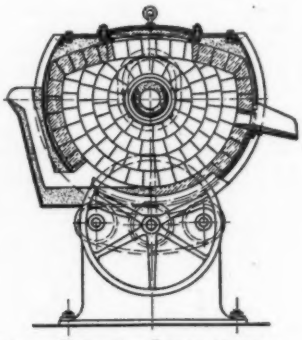

FIG. 5.—CROSS-SECTION OF HEARTH SHOWN IN FIG. 4.

## Jacketed Foundry Ladle.

BY M. A.

Supposing a foundry has to pour a casting weighing, say, 8 tons, but the cupola only melts from 4 to 5 tons per hour, it would require nearly two hours to melt this quantity of iron, and the greater portion of the molten iron or steel would have to be accumulated in a suitable vessel. But it is of great importance that the molten metal should be kept hot and at the same temperature as when it leaves the cupola. Hitherto the accumulation of large quantities of metal has been accomplished in three different ways:—(1) In the bottom of cupola; (2) in cupola receiver, the latter being in direct connection with the cupola; and (3) in an ordinary foundry ladle. Although every one of these three methods affords storage and accumulation for molten metal, none of them provides for maintaining the temperature at which the metal issues from the cupola, and the action of chilling upon the metal becomes very noticeable. The method of having the molten iron accumulated in the cupola (*i.e.*, a cupola without receiver), is, of course, the least profitable, and very often accompanied with serious consequences. The tuyeres of such a cupola will have to be placed considerably higher, and as the coke bed should reach at least 18 in. to 24 in. above the tuyeres, consequently for every heat from 4 to 5 cwts. more coke will be required for the bed. Further, if a large quantity of metal has to accumulate in the cupola, naturally its volume will rise, so the level of the melting zone will be raised, and after tapping the metal a similar drop or lowering of the melting zone will result. Finally, the metal in the bottom of the cupola, and, therefore, far below the tuyeres, receives no further heating, and can be kept in an open ladle for quite a considerable time in the same condition and temperature, provided the metal is covered with charcoal. The metal accumulating and kept in the bottom of the cupola is subjected to all kinds of impurities, quite apart from the fact that the storage demands great care from the furnace man, and the chances of bursting the shell or even the bottom of the cupola (especially with a drop bottom) are considerable.

Cupolas with receivers attached are frequently found in use. Strictly speaking, receivers are called upon to perform two duties, namely, to accumulate the molten metal and to act as a mixer in order to get a more uniform mixture from the various charges, which, even when using the greatest care, can never be of absolutely equal composition. One more important factor, however, remains yet to be accomplished by every receiver, namely, maintenance of the metal at the same temperature at which it leaves the cupola, or, at least, the prevention of chilling of the molten metal. In the usual type of receiver provision is made for keeping the top (the space above the metal) at a certain high temperature. The heat thus created in this portion of the receiver is of very little importance, because the chilling action and lowering of temperature of the metal begins at the bottom and round the walls, which regions are without any provision for further heat supply. On tapping the receiver, the metal, which by this time has cooled down considerably, finally passes into the pouring ladle, with a further drop in temperature. Further, the initial cost of cupolas with receivers is usually 15 per cent. to 20 per cent. higher than without receivers, and likewise cupolas with receivers

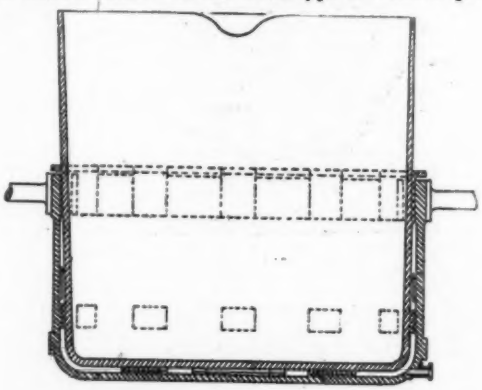

FIG. 1.

demand more care and cost of repairs than cupolas without receivers.

From the foregoing it will be seen that in many instances it would be of great value to have a receptacle, not only combining the receiver and pouring ladle, but also keeping the metal approximately the same temperature as that at which it leaves the cupola. An apparatus to fulfil these requirements is illustrated herewith.

The ladle, which is made of cast steel, is surrounded up to the level of the trunnions with a jacket, thus leaving a space of from 1 in. to 2 in. Into this hollow space a continuous supply of hot gases is introduced, the latter being obtained from the waste gases of the cupola or from some type of mould drier. The hollow space extends over the whole area of the ladle-bottom with the exception of a few supports. These supports are cast on the ladle and jacket respectively, and machined on the face in order to ensure a uniform seating of the ladle all over. The comparatively narrow space between the ladle and jacket gives rigidness to the whole apparatus, and two further rows of facings all round give additional strength when tipping the apparatus for pouring. This arrangement, apart from a few bolts, will do away with any riveting, and as the ladle and jacket

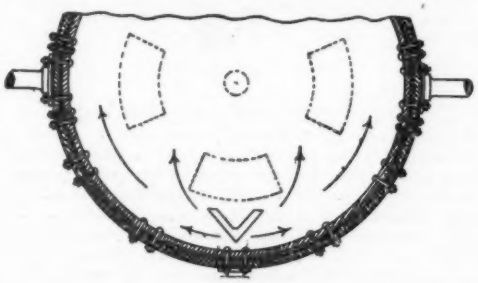

Fig. 2.

are of absolutely circular shape, the process of machining the facings is greatly simplified and facilitated.

The escape of the gases, after having heated the ladle, can be arranged in the form of a single outlet similar to the inlet, or by means of openings spaced at certain distances all round between flange of ladle and top of jacket. The trunnions, which of course are provided with the usual gearing for tipping the ladle, are bolted to jacket and ladle by means of specially strong bolts. The ladle is also provided with a cover or lid, not shown in the illustration.

This type of pouring ladle and receiver combined is said to be suitable for carrying from 3 tons up to 25 tons of metal. The temperature of the gases is from 400 degrees to 500 degrees Fah., and, therefore, the accumulation can extend over several hours without the metal being affected by chill. A casting, for instance, weighing 15 tons, could easily be poured from such a jacketed ladle, even if the cupola were only melting at the rate of from 4 to 5 tons per hour.

By means of a well-regulated mould drier, 10,000 cub. ft. of air can be heated up to 500 degrees Fah. per hour, and this requires the trifling amount of not more than 28 lbs. coke, which would be, in the above instance of a 15-ton casting, equal to about 1 cwt. of coke. This device was the subject of a recent patent.

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Mr. F. W. L. Clark has been elected chairman of the Globe Pneumatic Engineering Company, Limited, in place of Mr. S. N. Griffiths. Mr. Clark's father, the late Mr. R. I. Clark, was founder and first chairman of the company. Mr. Griffiths retains his seat on the board as vice-chairman.

## "F.T.J." Bookshelf.

### Metallurgy.

*By Ad. Fenchel, D.Sc. Translated by H. J. Morris, L.D.S. (Eng.). London: John Bale, Sons & Danielsson, Limited, 83-91, Great Titchfield Street, Oxford Street, W.*

We have here a metallurgical work which is somewhat distinct from most of the volumes appearing under that title. It is offered as a text-book for manufacturers, foremen, and workers in the metal industries, and gives special consideration to dental metallurgy, one of its chief objects being to instruct readers who are not able to understand the scientific literature on the subject without preliminary studies. It is intended to give them exact data about their working materials and the results of modern metallurgical research. At the opening an instructive portion deals with the internal structure of pure metals and of alloys; the analysis of metals is discussed at length, and the physical properties of metals are next considered. At some points, however, particularly on the thermic analysis of metals, the mass of detail and explanation will probably be bewildering to the reader "who is not able to understand the scientific literature on the subject without preliminary study." The conclusion of the first part of the book deals briefly and in clear and simple manner with the chemical properties of metals. The second part describes all the known properties of metals which the author regards as important, and the description of each alloy is accompanied by complete diagrams, arranged in atomic percentages, while a guiding line is added to those diagrams which makes it possible to read off the weight percentages without further trouble. The general treatment of the alloys considered is fairly simple, but the purely practical man will probably experience the difficulty that too much has been left for the diagrams themselves to express. This would have been obviated by a clear exposition of the equilibrium diagram, which would have placed the book on a far more practical basis; for there appears to be pre-supposed a knowledge of metallurgy and chemistry which may be comparatively elementary to the engineering student, but is often not possessed by the worker. The task of bringing such a subject down to the level of those who are not to a considerable extent versed in the scientific side of the trade is admittedly a difficult one, and we are not disposed to harshly criticise the author's efforts on that score. The book is a distinct advance on the usual elementary text-book, though there is room for improvement at points. Further, the addition of a somewhat long list of errata mars the appearance of the work, a defect which, of course, will be remedied in future editions.

### Mechanical Engineers' Price Book.

*Edited by Geoffrey Brooks. London: E. & F. N. Spon, Limited, 57, Haymarket, W.*

This is a useful little book for mechanical and constructional engineers, giving as it does the prices of a great variety of materials, ranging from such items as set screws to roof trusses and similar materials. The matter is divided into four sections, these being (1) constructional work; (2) materials and sundries; (3) pipes, tubes, connections, fittings, etc.; (4) power: generating and transmission. In each section the various items are alphabetically arranged, and cross references are made where they appear likely to be useful. There is also a detailed index at the end of the book, rendering quick reference easy.

# Green Sand Moulds without Patterns.

The making of moulds without patterns is most largely practised in loam moulding, in which case the dimensions of the bodies to be moulded are practically unrestricted, whereas in sand moulding by means of templets the articles are mostly shallow. Owing to the comparative scarcity of skilled moulders at the present day, this method of moulding is declining in importance, though of late it would seem that intelligent moulders are taking greater interest in it again. So far as the manufacturer is concerned, the production of the casting is naturally the main thing; and the method of moulding in question is undoubtedly the cheapest where the probability exists that only one casting will be required of the same kind, and where the dimensions are so large that the making of a pattern is attended with difficulty and increased expense. In every case the question of cost plays the leading part nowadays, and an accurate calculation should be made before-

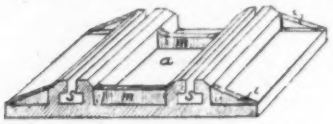


FIG. 1.

hand as to whether it is cheaper to make the mould from a pattern or without. This being settled, the work can be performed more quickly than with a pattern, always provided skilled moulders are available. In the absence of the latter, those founders who have not made a special study of this particular branch may gain some information from the following particulars and sketches relating to the progress of the work. Greater demands are made on the intelligence of the moulder, since he is required to be able to work from drawings, but since the moulding machine has relieved the sand moulder of the mechanical part of his work, it is essential that he should become accustomed to work of a higher character in his trade.

The appliances required are of a simple nature, and the items of general expense, such as bricks, loam, sand, fuel, etc., are much smaller than in loam

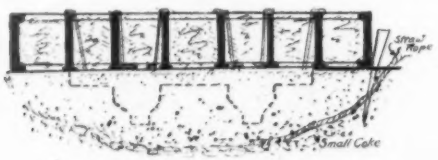


FIG. 2.

moulding, apart from the circumstance that moulding with a templet in green sand can be got through much more quickly than in the case of loam, since it frequently happens that loam moulds require to be dried after each stage of the process.

Take, for example, the bedplate shown in Fig. 1, of the kind used in many large iron works and engineering works; the dimensions frequently attaining 30 to 60 ft. in length, and about 15 ft. in width. The details, such as ribs, webs, recesses, oil collectors, etc., will, of course, vary from those shown in the illustration, which is merely intended to represent them as a whole. The casting consists of a flat plate with the two guide slots, *s*, which are stiffened on the bedplate proper by the central ribs, *m*, and lateral ribs, *i*. As can be seen, the making of a pattern of the dimensions specified would be a very expensive matter. Making up the mould by means of the pattern would also involve great difficulties in getting the sand rammed with sufficient firmness to stand the weight of 10 to 20 tons of molten iron. On this account a hole is provided at *a*, Fig. 1, to enable the surface to be rammed, and the cheeks of the slots *s* to be sufficiently under-rammed. This done, the hole in question is filled up with sand, which is sleeked off in the usual manner, the top box being then rammed on, and after the pattern has been emptied the projecting mass of sand, *a*, is cut away.

Fig. 3 shows the mould being prepared with the

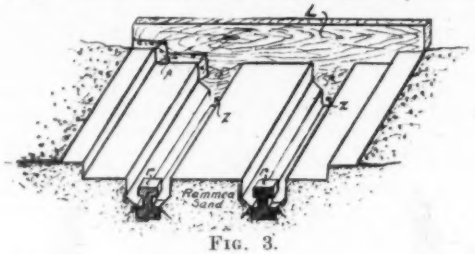


FIG. 3.

templet, for the same casting. The templet, *L*, is really the sole pattern required, and is shown in course of drawing through the mould, which it sleeks and compresses. In preparing the casting bed, a hole of sufficient size is dug in the floor, small coke being placed in the bottom, and a number of straw ropes laid in various directions to enable the gases to find a way of escape. A thick layer of sand is rammed over the foundation material, and this in turn is covered with loosely rammed moulding sand in which the mould is drawn by means of the templet, *L*, as shown in Fig. 3. The templet may be of ordinary thick wood, and is preferably shod on the lower edges with sheet iron, as indicated at *p*, Fig. 3, to protect it from wear; and, in such event, the rearward edge can be chamfered, which facilitates the work and improves the sleeking. At *z* a special tongue, which goes deeper than the pattern, is drawn through the sand, to provide room for the specially shaped slot core, *k*. The bottom member of this core is made particularly wide, so as to afford a firm

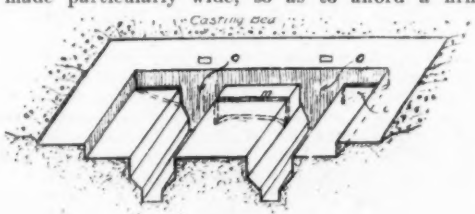


FIG. 4.

support. This arrangement also obviates the necessity for using heavy core spikes, which are always a source of trouble in planing the slots, the spikes being glass-hard and increasing the cost of planing. The H-section cores shown in Fig. 3 are fastened by spikes driven in at the sides, where they do not affect the casting, and can be removed at once in planing. The ends of the templet shape out the supporting surfaces for the moulding box at each side, though this part of the work can easily be done separately.

Where it is feared that the sand at the sides may give way under the heavy weights used for holding down the box, iron supports (trestles) should be embedded, as shown in Fig. 2, to support the box and weights. The cover box itself is laid on the previously rammed sand and hammered, its position being secured by iron or wooden wedges. The end surface of the mould is sufficiently represented at *o*, Fig. 4. The two rectangular holes shown above *o* are the pouring gates, which are connected by a channel and open into the sides of the slots at the bottom of the mould. The cover box is provided with a single pouring gate opening into the said channel. Fig. 4 also shows the central rib, *m*, and the lateral ribs *i*. The simplest way of making these is by embedding patterns before shaping the mould with the templet, though some moulders prefer to recess them with chisel and gouge, especially when the patterns represent waste. When the mould is ready, the cover box is laid on, sufficient play being allowed, and a fire is then built on the cover in the usual way. The cores are inserted in the dried mould, and the metal is poured in. This method of making moulds without patterns can be employed for a variety of castings in green sand, provided they are not too deep, and consequently it deserves better attention at the hands of the founder.—(*Eisen Zeitung.*)

## A Case-hardening Hint.

In case-hardening it often occurs that whereas certain parts of the surface of the piece in question require to be glass-hard, there are other parts which it would be of great advantage to retain soft, either on the score of strength or in order to operate thereon after the case-hardened surface has been quenched. A case of this kind occurred recently in the production of certain lathes. In the specification it was stated that the mandrels must be made with a hardened cone to run in a hardened bush in the front bearing of the headstock and also the surface of the after-end of the mandrel must serve as a thrust bearing, and must, therefore, also be hard. The mandrel is shown in Fig. 1, the parts requiring to

FIG. 1.—MANDREL, PARTLY CASE-HARDENED.

be hard being indicated by thick lines. The after bearing was formed of a loose cone sliding a tight fit on the seating A, which was feathered to receive it, this cone having its taper sloping in the opposite direction to that on the front end of the mandrel, and working in a hardened bush in the after bearing of the headstock.

It is obvious that to ensure accuracy the screw on the nose of the mandrel, the facing B on which the chucks and other attachments depend for their truth, and the taper bore to receive the live centre, must be finished with the mandrel running in its own bearing. The first mandrel made was accordingly finished completely as regards all parts except those named above. The bearing bushes and the loose cone were finished and hardened, after which the headstock was assembled sufficiently to enable the mandrel to be run. By using a low-speed to avoid any seizing on the mandrel cone, the nose and its shoulder and the taper were then finished. The featherways having been sunk, the mandrel was cased in the ordinary way, and when sufficiently impregnated was carefully quenched. Every care was used to avoid distortion, but nevertheless, the mandrels invariably warped, and since the whole surface was hard, it was impossible to correct the errors by any lathe operation. Grinding was tried, a small allowance being left for the purpose, but was found to be difficult and expensive, and generally unsatisfactory. The difficulty was successfully got over in the following way, the method employed being applicable to all case-hardening work.

The new mandrel was first of all "roughed out" all over to within 1/16 in. all over of finished size, *i.e.*, 1/16 in. was left to come off all faces and $\frac{1}{8}$ in. off all diameters. The front cone bearing was next finished with the exception of leaving about 5/1,000 in. on the diameter for the final grinding. The hole for the live centre was left blank. The mandrel was baked in the case-hardening compound in the usual way, sufficient to carbonise to a depth of about 1/32 in. all over. After baking, the mandrel was allowed to remain in the muffle with the heat cut off until cold, this thoroughly annealing it. It was then removed, and when thoroughly cleaned of all dirt and scale was put back in the lathe and reduced all over to within a few thousandths of an inch of absolute finish. By this process the cased portion surrounding the parts which were ultimately required to be soft, was entirely removed. The mandrel was then carefully re-heated, and when the required temperature was reached, quenched in the usual manner. Since the only parts now remaining which had been exposed to the case-hardening agent were the conical front bearing and the after-end, it follows that these were the only parts subsequently hardened by the re-heating and quenching. After another thorough clean the mandrel was placed in the grinding machine and the cone was finished. It was then removed to the lathe, the cone being run in a fixed steady rest set up near the headstock. The carrier was placed on the unfinished nose and between the nose of the mandrel and the driver-plate a piece of wood attached to the lathe was inserted to prevent the cone slackening back out of the steady rest under the pressure of the dead centre. The shank of the mandrel was then screwed in the appointed places and finished true all over. After the featherways had been sunk it was assembled into its own headstock and the nose was screwed, the shoulder faced up and the hole from the live centre roughed and finished. In this manner a perfectly accurate job was made.

A further objection to case-hardening any piece all over lies in the fact that, if there are any thin parts or sharp edges, these are likely to become converted right through, the result being that after quenching, such parts are exceedingly brittle. An illustration of this effect may be found in the cups of an ordinary cycle ball-bearing, the walls of which are very brittle. Again it was found in the case of the first mandrel described above that the edges of the screw threads were extremely brittle and liable to chip, this being particularly so in the fine threads. This objection was, of course, entirely removed in the case of the mandrel, by the process described.

It was also found that ball-bearing cups made on similar lines were a great improvement on those made in the old manner. In the case of these cups the ball race was first finished within grinding allowance, the outside of the cup being left 1/16 in. "full" all over. The cups were then cased and annealed as described for the mandrel; after which the outsides were reduced to within a few thousandths of the finished size, and the cups re-heated and quenched. The ball races were then ground out true, and the outside of the cup finished, the result being a glass-hard race and soft backing.

# Pellets and Segregation in Iron Castings.

Before the Lancashire Branch of the British Foundrymen's Association, on Saturday, February 3, at Manchester, Mr. F. Penlington (President of the Branch) in the chair, a Paper was read by Mr. E. L. Rhead, M.Sc.Tech., of the Manchester School of Technology, on "Pellets and Segregation in Iron Castings."

The segregation and concentration of the constituents of cast iron had, said the lecturer, an important bearing, not only on the characteristics occasionally displayed by iron when some extraordinary features, such as pellets, etc., were prominent, but also on its ordinary properties. If no separation occurred, the use of cast iron for the purpose for which it was now employed, would be impossible. The complex nature of the material was now well known, and the names of its constituents had become common words in use, but many foundrymen who talked freely about them, did not appreciate the manner in which the substances occurred, nor the quantities. Quotations of the percentage composition of cast iron were in every man's mouth nowadays, but it was doubtful whether everyone appreciated the meaning of the quantities he talked about. The silicon, carbon, and other constituents were thought of as existing as simple individual substances, whereas they did not. Chemical combination completely destroyed the specific properties of the elements combined; the compounds had properties of their own, differing entirely from the separate elements, and they caused the metal to depart widely from the condition of wrought iron. For example, carbon formed a carbide which was generally represented as having the composition $Fe_3C$. Fortunately, the whole of the carbon present in the iron was not in the combination, otherwise when pig-iron contained 3½ per cent. of carbon there would be very little iron left. But while such of the carbon as existed in combination produced 15 times its weight of carbide, which had a definite existence and was present in that form, the remainder of the carbon separated out in the form of graphite. Silicon formed a silicide on which the silicon was only one-third of the compound. Phosphorus gave a greater amount of trouble, and of the possible phosphides the two best known were $Fe_3P$. and $Fe_3P_2$., containing respectively 15.5 and 31.1 per cent. of phosphorus. Sulphur formed a sulphide of which 36.3 per cent. was sulphur. Speaking generally, something like 5 to 7.5 per cent. of silicide, 12 to 14 per cent. of carbide, and 10 per cent. of phosphorus might be present in an ordinary casting. Thus to get at the actual amount of iron in the casting it was necessary to deduct approximately 31½ per cent. of the total mass, and the remaining two-thirds would include the graphite.

To put it in concise form, the properties of the metal would depend on the readiness and completeness with which these bodies mixed with each other and with the remainder of the metal, both when molten and after cooling. If they were completely soluble and no separation occurred, the metal would have a uniform structure; if separation occurred the structure would not be uniform.

### Saturation and Super-Saturation.

A solution was formed by the dissolving of one body in another—it was usual to refer to the larger of the two bodies as the solvent—and the mixture was said to be saturated when under the existing conditions, no more of the substance would dissolve. This point might be arrived at in two ways: (*a*) By adding the dissolving body until no more was taken up; (*b*) by altering the conditions so that under the new conditions the solution was saturated. A super-saturated solution was produced when the solution was cooled down perfectly quietly without disturbance, and was in such a condition that if an additional portion of the substance were dropped in, the excess of material dissolved in it would fall out almost immediately. It was interesting to know that whilst solids dissolved in liquids in larger amounts as the temperature rose, it was equally true that gases dissolved in metals to a greater extent at high temperatures than at low temperatures. In pig-iron there were a number of substances which were dissolved mutually by each other. Each was exerting a certain influence on the retention of the other substances in solution and if any one was taken out its removal would affect the solubility of the others. If one of the substances were increased in amount the solubility would also be affected — either diminished or increased, as the case might be. The presence of a substance in solution had the effect of lowering the melting point of the solution into which it entered, and as an instance might be taken the case of common salt.

### Complicated Changes in Casting.

The complex nature of cast iron caused the changes to be complicated, and the raising or lowering of the mean melting point would be dependent on all the constituents. Such a system had not been fully investigated up to the present, and it would be seen that the possibilities were very great. As the temperature fell the excess of one constituent after another might separate, and the withdrawal of these from the main mass might cause a separation of others, either separately or in solution, leaving at each step a fusible residue constantly depleted of the bodies of higher melting point. The greater the range of temperature over which this occurred the greater would be the degree of separation possible. Quenching and rapid cooling prevented the completion of the changes, but they might be recommenced and completed by heating to the temperature at which it was arrested, as in annealing. The highly complicated structure of cast iron was due to these causes, and its strength, uniformity and other properties were dependent on the selection of a mixture that under the conditions required would give the structure required.

### Classification of Separated Bodies.

The separated bodies that occurred in a cooling mass might be regarded as of two orders: (1) Those that separated from a saturated solution, becoming solid before the bulk of the material; (2) those that were left liquid as the bulk of the material solidified, or they might be regarded as rejected by the solidification of the other constituents. The second class might be sub-divided into those left fluid, and which solidify as a whole, and those that separated after solidification. He would deal first with those in the first class, comprising bodies which had a high melting point and low solubility.

*Graphite.*—This occurred in a separated form in the softer types of cast iron. When cast iron was in a perfectly melted condition all the carbon present was in solution. Metal in the ladle often contained less carbon than the original mixture, due to the pig-iron having been produced and saturated with carbon at a higher temperature than was attained in the cupola. Often, when standing in the ladle, the molten metal threw up a scum; the graphite was separating while the metal was cooling, and being comparatively

light was floating up. Its production pointed to the fact that the metal contained more carbon than it was capable of retaining at the temperature at which it was being cast, and that it was not suitable for making strong castings. Even when poured the graphite would continue to separate; as long as the material was fluid the graphite would collect and rise to the highest attainable point. After solidification had commenced the remaining carbon would separate in the usual manner; that is to say it would remain distributed through the iron, and the size of the flakes would depend on the rate of cooling. Such metal might make satisfactory thin castings, providing the separated graphite could be got rid of by allowing it to pass into a riser, or head, or in a similar way. When the carbon was not separated at the pouring temperature, the metal might enter and fill the mould completely without any separation taking place, but as it cooled the saturation point was passed and a deposit of carbon commenced. Nuclei were first formed, and on these further deposits took place as the temperature fell and the saturation limit was lowered. This would continue as long as the metal was sufficiently hot to permit of free movement, and it produced coarse graphite. Carbon concentration occurred in the vicinity of the graphite flakes, but as the freedom of movement became more restricted the carbon particles could not be readily transmitted, and fresh centres of deposition resulted, producing finer graphite. This continued till cooling was completed. When the saturation limit was not reached till the metal had cooled considerably, and freedom of movement of the particles was restricted, coarse graphite did not form. If at any stage the liberty of movement was arrested, as by cooling, the condition of the constituents remained as it was at the temperature at which it was arrested. Slow cooling, therefore, permitted the most perfect separation.

Certain bodies, such as silicon in some forms of combination, promoted the decomposition of the carbide and lowered the saturation limit, thus promoting the formation of graphite, and irons yielding kish were usually high in silicon.

*Effects on Casting.*—The separation of this lighter body, occupying a larger space than it did in solution, helped to compensate for the contraction which took place as the metal cooled, and thus prevented the development of internal stresses of as great a magnitude as would otherwise be produced. The separation of the temper graphite that occurred when the separation was recommenced and completed in softening and annealing processes was responsible for the increase in size of the casting which took place when thus treated. The action of the silicon in promoting decomposition of that carbide and separation of the graphite was well shown by the absence of graphite from white irons, and the retention of the carbon as carbide; further, by the lower temperature at which the separation recommenced when irons containing more silicon were heated in the process of annealing. The following striking figures by Charpy showed this :—

| Percentage of silicon present. | Carbon contents. | Temperature at which carbon began to separate. Deg. Cent. |
|---|---|---|
| 0.07 | 3.60 | 1,150 |
| 0.27 | 3.40 | 1,105 |
| 0.80 | 3.25 | 800 |
| 1.25 | 3.20 | 650 |
| 2.10 | 3.30 | 650 |

In the last case 85 per cent. of the carbon was deposited by six hours' heating.

*Phosphorus.*—Next to be considered was an element, the segregation and concentration of which played a very important part in determining the strength and character of iron castings. That was phosphorus. Phosphide of iron was the most fusible constituent of the iron, and consequently lowered the melting point of iron solutions into which it entered to a greater extent than any other substance present. It was completely dissolved by cast iron when the metal was in the molten state. Iron free from carbon would retain phosphide in solution up to 1.7 per cent. of phosphorus, and in order that the carbon should produce the separation of the phosphide it must be present as carbide in the solution; as graphite it had no effect. Silicides retarded the separation, and much of the phosphide might be retained in solution till some of the graphite had been separated. As the temperature fell the excess of phosphide formed, with the other fluid portions of the metal, a liquid which had a very low melting point; this liquid continued to deposit some of the constituents with a higher melting point, became enriched in phosphorus and remained molten till the final solidification. Consequently, in general, it occupied middle areas in the course of solidification, which might unite and form a meshed network, showing up in patches on the surface of the metal. The continuity of these would depend upon the amount of phosphorus, the composition of the metal, and the rate of cooling. If they were continuous the properties of the casting would be dominated by those of the phosphide; it would be brittle when cold, weak when hot, and it would also be harder. The brittleness unfitted such castings for strong machinery or where jarring and vibration had to be encountered; the weakness might lead to fracture while cooling. The inference to be drawn was clear. In strong, close-grained castings, the silicon contents of which were kept low to ensure closeness and strength, phosphorus must be kept low. In some cases for great strength, 0.2 or 0.3 was the maximum. He might point out here the tendency manganese had to produce a carbide, and for that carbide to remain in solution in the metal had the same effect as the carbide of iron; it tended to promote separation of the phosphorus in the same way and bring about a weakening of the material.

### Formation of Pellets.

The relative behaviour of carbon, silicon, and phosphorus would explain the vagaries observed when examining different samples of cast iron. In some cases a singular but well-known effect was produced, viz., the formation of pellets. These sometimes occurred in the metal, occupying a kind of cell which they did not completely fit, a distinct crack being visible. That was due to the fact that the phosphide had collected into a pellet while the metal was soft enough to be moulded round it. In other cases, they were found loose in cavities in the casting, and these were produced in a somewhat different manner. During the solidification, so long as there was a clear way through between the crystals, the pressure squeezed the fluid metal into any cavity that might exist.

The lecturer produced a number of samples, and explained that he had made analyses of their composition, and also of the composition of the metal in which they were found. In all cases the percentage of phosphorus present in the pellets greatly exceeded that in the metal.

There was one other case in which the separation of the phosphide produced trouble. The difficulties in drilling and machining arising from the hardness of the imbedded pellets, and their tendency to drop out, was well known. In very thin castings it was usual to employ highly phosphoric iron in order to secure perfect running and perfect shape in the casting. If the metal cooled as it was running over the surface of the mould, as it must naturally do, it followed that the least fusible portions would be first

abstracted, leaving the more highly phosphoric fusible metal to go forward. This would result in the part furthest from the runner being more phosphoric and harder.

There might be, as happened once within his knowledge, two streams of metal flowing in under conditions which made the filling of the mould comparatively slow. The two streams had to come together and unite. In drilling a number of small holes, one part of the casting was found to be hard always where the metal went last, the result of the increased phosphide left in the part of the metal which had finally filled the mould. Under such circumstances, the metal was fluid enough to amalgamate properly at the point of junction, but there was a hard place across the junction, owing to its being more highly phosphoric.

Sometimes in the interior of pig-iron there were found portions of a different character from the outside of the sample. Such a case he investigated and got the following percentages:—The outside metal: Silicon, 2.7; phosphorus, 0.378; sulphur, 0.073. The inside: Silicon, 2.7 (the same); phosphorus, 0.49; sulphur, 0.096. The figures followed the same sequence as in the case of the pellets contained in the iron. It pointed to the fact that under certain conditions the impurities might collect in the centre of the pig-iron instead of being uniformly distributed.

### Discussion.

Mr. D. Cordingley asked whether sulphur could be made into a gas and come off from the iron?

Mr. Rhead said sulphur was not volatilised in melting iron. He had not had time at that meeting to go into the question of sulphur segregation, and it really collected in a somewhat different manner. He thought Mr. Cordingley wished to be clear about the cause of holes when sulphur was present. It was due to the fact that the presence of sulphide of iron increased the solubility of the gases in the metal, so that in cooling down there was a greater liability for holes to be produced, as the result of the separation of the gases.

Mr. T. W. Markland asked whether when the metal was poured into the mould, and a scummy surface was seen, was that caused by the carbon separating from the iron?

Mr. H. Sherburn (Secretary) said he understood that apart from the question of fluidity, the reason why it was customary to use an iron high in phosphorus for the production of light castings was economy. Irons with 1.5 per cent. of phosphorus were the cheapest irons they could get. He had experimented with irons of a lower phosphorus content, and got equally good results.

Mr. W. H. Sherburn remarked that Mr. Rhead had referred to places where the hole did not fit the pellet. He did not quite know how Mr. Rhead explained that, because it seemed to him if the pellet were formed when the metal was cooling the hole would always be similar in size and shape to the pellet. One or two of the pellets produced looked as if they had cooled and then been thrown somewhere else in the middle of the mass and got held there.

Mr. Rhead replied that the pellets were absolutely loose inside the hole.

Mr. W. H. Sherburn said when iron fell to the bottom of a sand mould it was bound to gather something round it which would prevent it from melting again, and it would be thrown further into the mould. That was his only explanation.

Mr. J. Simkiss said he did not quite agree that foundrymen were prejudiced against the intrusion of chemists; on the contrary, their advice was very welcome. But one reason why the chemist was not more employed was that the work became standardised and commercial considerations checked experimental work to some extent. It was costly, and whether the mixture came out as anticipated or not the castings had to be sold; they could not be put on the scrap heap. With regard to pellets being formed, on a recent occasion he noticed a head of about 60 lbs. weight sink rather rapidly and form a cavity in the centre, and into this cavity innumerable little mouths opened and ejected at a very high temperature, small portions of metal, which formed pellets. These pellets were retained at the end of each mouth that opened. Perhaps Mr. Rhead would explain the cause. With regard to the minute hard specks on the surface of small castings that showed up in machinery, he attributed that to faulty runners or gates, and had proved this to his satisfaction on several occasions.

Mr. Rhead, answering Mr. Markland, said the scum which formed in the running of a casting was exactly like that which formed in the ladle, with the exception that some oxide was also formed which, of course, had separated as a scum on the surface of the stream of metal. The fact that graphite showed up badly in one particular place had been referred to. Sometimes—in fact, very often—they found with light castings which were run with a highly siliceous metal, that they had a kishy surface on the metal—perfect plates of graphite, which could be distinctly seen, separated from the metal. The reason why phosphoric iron was so cheap was that there was such a large amount produced, and it could not be used for anything but foundry purposes; an outlet had to be found for it, and it could only be used for castings which required to be light. Perhaps it would be better to say there were certain classes of iron which contained too little phosphorus to be used for steel making, and too much phosphorus to be used for anything but foundry purposes. It was said that castings could be made with iron containing little phosphorus. Quite true, but the metal had to be got hot, and the castings were not quite of the same quality as when made with phosphoric iron; they did not run so well, and the melting point of the metal was higher. Perfectly soft castings could be made if the metal could be got hot enough to run; phosphorus enabled the metal to be run at a lower temperature. That was the whole point. Its application to the manufacture of hollow ware was well known.

It was said, quite correctly, he continued, that on the surface of castings it was possible to have pellets that were not of the nature that he had referred to, but they would find that in such cases the pellet was embedded in the iron, and there was only a little mark round the outside, just a little hollow round the point where the pellet was. Very often the pellet had got properly embedded in the iron, and was held by the iron, simply because the hot metal had re-dissolved the solidified surface and had united to it perfectly. Pellets of that sort were got from splashes. But the other pellets he had referred to, which were embedded in the castings, were not of that nature at all, and could not possibly be produced in that way, for the simple reason that if they were due to splashes the composition of the pellet would be identical with that of the metal in which it was embedded. As a matter of fact, it was highly phosphoric. The reason these phosphoric particles remained embedded was that the specific gravity, that is the density, of the phosphoric pellets was practically the same as that of the metal; consequently they would stop exactly where they were produced, suspended in the material, and the metal would solidify round them; but when the phosphoric material itself came to finally solidify it shrank slightly. In the cold state it did not occupy quite as big a volume as when fluid. The result was that little crack which one could

very often trace round the outside of the pellet. There was a shrinking away from the cell that held it while it was in the liquid state, and the metal was in a solidified condition. Where pellets had separated in this way with a distinct crack he thought there could be very little doubt that they were directly due to the concentration of the phosphorus in the way indicated. Mr. Simkiss had referred to the work being standardised. He (Mr. Rhead) did not altogether agree. Pig-iron varied to such an extent in different deliveries that it was always necessary to keep a close watch upon the quality of the metal and, according to the condition, to vary its use in such a way that it would produce the best results. Pig-iron manufacturers were wakening up to the importance of producing metal of a more or less definite composition, or to specification. When that day came, perhaps the chemist would not have quite as big a show, but at present there was a very big place for him if he and the foundryman would work together and trust each other. The case Mr. Simkiss cited of the exudation of fluid matter on the surface was an instance of the formation of pellets. It was due to the contraction going on lower down. It was probably a deep casting in which this occurred, and in such cases frequently the contraction going on at the bottom squeezed the fluid up. He had found similar formations on the surface of castings—small pin-head pellets dotted over the surface.

A vote of thanks to Mr. Rhead concluded the proceedings.

## Tests of a Sand-Blasting Machine.*

By W. T. Magruder.

This Paper gives the records, results and conclusions of a series of quantitative tests of a sand-blasting machine, under the actual conditions of commercial practice, which were made by David H. Ebinger and Robert A. Frevert, of Columbus, under the direction of the author. As a complete solution of the problem of securing quantitative results under such conditions was impossible in the time available, certain of the variables which present themselves in such a problem were assumed to be constant; (*a*) the material to be sand-blasted; (*b*) the character of its surface; (*c*) the air-pressure best to use with each of these materials and conditions; (*d*) the size of nozzle for different classes of work; (*e*) the angle to the surface of the work at which the nozzle should be held; (*f*) the distance from the work at which the nozzle should be held; (*g*) size, sharpness, kind, character, uniformity of size, and cleanliness of the sand, and the number of times it has been previously used for sand-blasting; (*h*) the relative dryness of the sand and of the compressed air of the blast; (*i*) the proportion of sand to air; (*j*) differences in commercial machines.

The conditions of this set of tests were as follows:—The material was pieces of cast iron which had been broken as test bars for transverse tests. They were 2 in. by 4 in. in cross-section, and from 15 to 25 in. long. They had been cast diagonally on edge in one mould from one ladle of machinery iron. Their rough surfaces were as uniform as were the bars themselves. A new nozzle, $\frac{4}{16}$ in. in diameter, was used for each test. To remove any unevenness of the interior surface of the nozzles, and to bring them all exactly to the same condition, sand was blown through each for two minutes previous to starting the tests. No tests were made with other sizes of nozzles. The sand used was a No. 3-J Cape May grit, new, hard, sharp, clean, free from clay, and was such as is commonly used by the trade. It was thoroughly dried before being used. Great care was taken to avoid overheating it and so destroying its strength and cohesion. The sand was then passed through a No. 8 mesh screen. After use in the machine, it was weighed, sifted, re-weighed, and discarded. New sand was used for each test. The compressed air was passed through a separator to relieve it of moisture from the atmosphere and oil from the compressor. No attempt was made to regulate and adjust the proportion of air to sand, all tests being run with the regulating valve wide open. No comparisons were made of the operations or results from different machines on the market.

Upon the three remaining variables, the air pressure, the angle between the surface of the work and the nozzle, and its distance from the work, the quantitative experiments were made.

From these quantitative experiments on a cast-iron test bar for these three variables, within the limits used, the results were as follows:—

(*a*) For a constant distance of 8 in., and at a constant angle of 45 deg., between the nozzle and the test bar, the equivalent amount of free air delivered per minute, the iron removed, the sand discharged, and the sand used up per 100 cub. ft. of free air flowing per minute, vary directly with the pressure; the per cent. of usable sand remaining, and the amount of sand discharged per lb. of iron removed vary inversely with the air pressure in the machine.

(*b*) With a constant pressure of 60 lbs. in the machine, and a fixed distance of 8 in. from the nozzle to the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the angle between the nozzle and the surface of the work was from 40 to 60 deg.

(*c*) With a constant pressure of 60 lbs. in the machine and a constant angle of 45 deg. between the nozzle and the surface of the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it when the distance from the nozzle to the work was about 6 in.

(*d*) With a constant pressure of 60 lbs. and a fixed distance of 8 in. from the nozzle to the test bar, the amount of sand used up varies as the directness of the blast.

(*e*) With a constant pressure of 60 lbs., and a constant angle of 45 deg. between the nozzle and the test bar, the amount of sand used up varies inversely with the distance of the nozzle from the test bar.

(*f*) For a constant angle of 45 deg., and a fixed distance of 8 in. between the nozzle and the test bar, twice as much metal was removed at 56 lbs. pressure as at 20 lbs.; at 64 lbs. as at 30 lbs.; and at 72 lbs. pressure as at 40 lbs.

(*g*) With a constant pressure at 60 lbs., and a constant distance of 8 in. between the nozzle and the test bar, over 20 per cent. more metal was removed with the nozzle held at 45 deg. than at 90 deg. to the test bar.

(*h*) With a constant pressure of 60 lbs., and a constant angle of 45 deg. between the nozzle and the test bar, 60 per cent. more metal was removed when the nozzle was held at 6 in. than at 10 in. from the test bar.

Unless it can be shown that the extra cost of compressing 100 cub. ft. of free air per hour to a pressure of 70 or 80 lbs. per sq. in. exceeds the cost to compress it to 30 or 40 lbs. by the cost of an hour of labour, the higher pressures, delivered at an angle of about 45 deg., and at a distance of about 6 in. from the work, are to be preferred for the sand-blasting of cast iron.

* Abstract of Paper presented before the American Society of Mechanical Engineers.

# Correspondence.

## The Casting Temperatures of Cast Iron and Other Metals.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—I agree with what Mr. J. Peers says on page 111 of your February issue, but he does not go far enough. All metals and alloys should be as *fluid* as their nature will allow at the time of pouring, but this in itself does not by a long way say that they should be as *hot* as they can be made. Indeed, in many cases beyond a certain temperature, metals and alloys thicken and become sluggish with increased heat.

Iron should be melted quickly in a cupola—this being a melting furnace, and not a smelting furnace in which chemical changes are needed—and it should be brought down in a fluid state; but excessive heating should be avoided, as also should excessive blast pressure. This will tend to prevent the alteration of the content of the alloy, provided really good coke is used, but the phosphorus content may be higher, if desired, as the metal at the proper casting temperature should set quickly enough to prevent chemical changes of a serious character. On the other hand, slow melting, and too high temperatures both tend to promote chemical changes, while if sulphur is in excess in the coke, probably in many cases it would be picked up. Even in crucible melting with closely luted covers on the crucibles it is possible to make great changes in the content of the molten metal, and probably crucible melting is the best form that can be used where expense is not too closely studied, as in some forms of tilting furnace the cost of crucible melting is reduced to a remarkable figure.

It is also possible, however, to make iron fluid by chemical means, and that without unduly raising the temperature, while at the same time sound and strong castings are obtained, the cost being less than one halfpenny per hundredweight of molten metal. But this is another matter. There is, however, no reason why unsound iron, brass or bronze castings should be made if care is taken in melting and pouring at a right heat, while even scrap of a mixed character can be made to pour as soundly as the best new mixtures. Even spilliness in brass strip ingot can be avoided if proper means are taken, but usually some chemical treatment has to be resorted to.

Yours, etc.,
WALTER J. MAY.

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*To the Editor of the* FOUNDRY TRADES JOURNAL.

SIR,—I notice in the current issue of your JOURNAL Mr. J. Peers discusses the casting temperatures of cast iron. From his remarks he seems to doubt that with large castings, the higher the temperature at which the metal is poured, the more dense and solid they will be. In discussing "shots, blowholes, and cavities in iron castings," at the meeting at Birmingham in December last, of that Branch of the B.F.A., I made the above statement. The statement was also confirmed by many experienced foundry men who were present.

With reference to the large square casting that Mr. Peers cites, he pours the metal into that casting at such a temperature as will prevent sinking. By doing this he does not get a solid casting. If he were to cut the square casting through the centre he would find sponginess and contraction holes present. The caving in of the sides of the same casting, poured as hot as possible, feeds the centre of the casting, and this casting would be found to be sound in the centre. By using a suitable cast-iron and a high pouring temperature, castings of this section can be turned out dense, solid, and sound. In Mr. Peers' endeavour to prove his own point he proves that the hotter the casting is poured the more solid the casting will be. This example will, perhaps, help Mr. Peers to understand the sentence, "the more solid the casting will be." Of course, it is conceded that with a large, square casting, such as Mr. Peers discussed, the object is to get the sides free from "sinks," and it does not matter if the interior is hollow. It would be a very serious matter, however, in the case of, say, a steam-engine cylinder, the thick portions of which were spongy or hollow. This is bound to be the case if a high casting temperature is not used in pouring same.

Perhaps Mr. Peers is not aware that the hotter cast iron is poured the denser that iron is, and the smaller the flakes of graphite in the resulting casting, therefore the stronger the casting. Allowing iron to cool in the ladle promotes the formation of large graphitic carbon much more readily than casting the metal as soon after tapping from the cupola at as high a temperature as possible. Again, the segregation of phosphorus and sulphur compounds, and the liberation of gases, are more pronounced and harmful in a casting poured with iron that has been allowed to cool in the ladle than in one cast hot.

If Mr. Peers will study the equilibrium curve of the iron carbon alloys he will find that the range of temperature for the separation of graphite in large flakes is fairly high, and that zone of temperature is soon passed through by a cooling casting. The graphitic carbon always grows more rapidly in molten than in solid iron. It is also well known that in test-bar work to get the best results both in tension and transverse testing the bars must be cast as hot as possible from the cupola.

In conclusion, I again state, to get the most dense and solid casting, for example, a high-speed steam engine cylinder, providing the proper mixture of iron is used, and the methods of placing the "gits" and runners are correct, it is necessary to run the metal as hot as it can be got from the cupola.

Yours, etc.,
GEORGE HAILSTONE.

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## Chilled Castings.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR.—While the remedy of the really hot ladle mentioned by Mr. Geo. H. Foston, will in many cases prove a remedy, the conditions under which the first charge in the cupola is brought down should be studied, as often this is open to objection in many ways.

At the same time, the practice followed in many places of running the first charge for making rough castings (provided clean metal is used) is not quite such a disadvantage as many persons seem to think, because it leaves both cupola and ladles in a good state for the following metal, both in regard to heat points and the removal of material from the cupola which is best out of it.

Lighting a cupola with wood coated with gas-tar or paint, or which contains a large amount of wrought iron in the form of nails or hooping, does not improve the first few tappings of metal; but of course such small items are beyond the notice of our metal experts.

Yours, etc.,
WALTER J. MAY.

# Queries.

### Pig-Iron for Malleable Castings.

Will you kindly tell me what are the most suitable kinds of iron for the production of first-class malleable castings for cycle and motor work, the castings ranging from ¼ lb. to ¼ cwt.? I can never get to know the brands of iron used, as we have the metal melted for us in a cupola. "MOTOR."

*Answer.*—The classes of pig-iron usually employed for the production of malleable castings are those known as No. 5 grey, soft mottled, hard mottled, and white. There are also intermediate grades known as medium mottled and spotted white. These are used in varying proportions, according to the work on hand. The characteristic feature of these irons is the high content of combined carbon with low graphite, the combined carbon being greatest in the white and least in the grey iron. The following are a few representative analyses of well-known brands of white, mottled and grey iron, reproduced from the analyses published in our columns in 1908 and 1909 :—

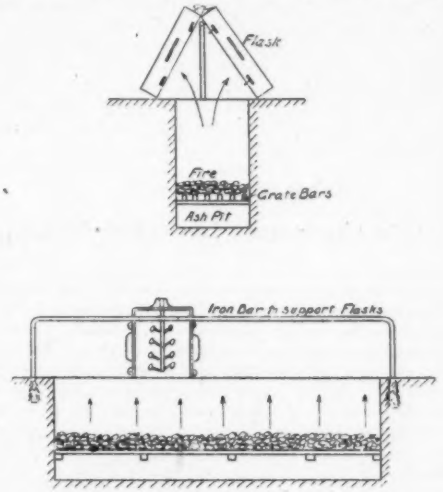
*Percentages.*

| Brands. | C.C. | G.C. | Si. | S. | P. | Mn. |
|---|---|---|---|---|---|---|
| **WHITE IRONS.** | | | | | | |
| Millom | 3.000 | 0.100 | 0.560 | 0.150 | 0.038 | 0.200 |
| Lorn | 2.820 | 0.100 | 0.118 | 0.004 | 0.050 | 0.180 |
| Renishaw | 2.650 | 0.100 | 0.450 | 0.250 | 1.350 | 0.250 |
| Stanton | 1.700 | 0.600 | 0.470 | 0.410 | 1.080 | 0.130 |
| Staveley | 2.320 | nil | 0.510 | 0.400 | 1.270 | 0.480 |
| Carlton | 3.100 | 0.120 | 0.880 | 0.280 | 1.400 | 0.300 |
| Tyneside hematite | 3.500 | 0.400 | 0.500 | 0.200 | 0.055 | 0.600 |
| S.C.M. | 3.250 | 0.200 | 0.400 | 0.220 | 0.050 | 0.250 |
| Askam | 2.800 | 0.300 | 0.490 | 0.160 | 0.040 | 0.200 |
| Holwell | 2.950 | 0.350 | 0.605 | 0.231 | 1.203 | 0.274 |
| Redbourne | 2.285 | 0.675 | 0.450 | 0.155 | 1.295 | 1.100 |
| Clarence | 3.100 | trace | 0.930 | 0.250 | 1.520 | 0.300 |
| Ormesby | 1.868 | 0.422 | 1.140 | 0.739 | 1.496 | 0.216 |
| **MOTTLED IRONS.** | | | | | | |
| Millom | 1.700 | 1.500 | 0.550 | 0.130 | 0.036 | 0.250 |
| Lorn | 1.500 | 1.820 | 0.530 | 0.004 | 0.060 | 0.050 |
| Renishaw | 1.560 | 1.550 | 1.200 | 0.200 | 1.500 | 0.350 |
| Stanton | 0.850 | 1.280 | 0.970 | 0.220 | 0.850 | 0.250 |
| Staveley | 1.080 | 1.100 | 0.850 | 0.200 | 1.430 | 0.540 |
| Carlton | 1.250 | 2.050 | 1.790 | 0.190 | 1.450 | 0.320 |
| Tyneside hematite | 1.500 | 2.000 | 0.800 | 0.100 | 0.054 | 0.800 |
| Askam | 1.600 | 1.500 | 0.600 | 0.150 | 0.039 | 0.190 |
| Holwell | 1.560 | 1.650 | 1.130 | 0.163 | 1.255 | 0.288 |
| Redbourne | 1.520 | 1.480 | 1.325 | 0.100 | 1.296 | 1.130 |
| Butlin | 1.179 | 1.166 | 2.660 | 0.168 | 1.648 | 0.216 |
| Clarence | 0.870 | 2.500 | 1.310 | 0.153 | 1.500 | 0.330 |
| Ormesby | 1.580 | 1.900 | 2.000 | 0.260 | 1.492 | 0.360 |
| **GREY IRONS.** | | | | | | |
| Lorn | 0.950 | 2.320 | 0.522 | 0.007 | 0.061 | 0.216 |
| Millom, No. 5 | 1.330 | 2.600 | 0.900 | 0.130 | 0.034 | 0.400 |
| S.C.M. | 0.600 | 2.900 | 1.500 | 0.120 | 0.050 | 0.400 |
| Askam | 1.200 | 2.500 | 1.000 | 0.140 | 0.038 | 0.800 |
| All Mine (Bradley) | 1.200 | 2.100 | 1.700 | 0.080 | 0.950 | 0.820 |
| Lowmoor | 0.810 | 2.570 | 0.736 | 0.089 | 0.383 | 0.839 |

Opinions as to what constitutes the best mixture for any specific purpose vary so much that it is difficult to find any two foundries agreeing on the matter. For thin, light castings of special quality, "soft mottled" or "grey" iron is the best, but where the work is not of such a special nature the foundry's hard scrap in the proportions of 1 to 4, or 2 to 3 of "soft mottled" may be used. For special work in thicker sections, say, up to 1½ in., "medium mottled" can be well employed, while for general work of the same section "hard mottled" with hard scrap in proportions of 3½ to 1½ respectively, is suitable. This may be varied by using "soft mottled" 2½ and "white" 1, in place of the hard mottled. As the section increases the hard scrap may be increased to 2 in 5, though "hard mottled" or "white" alone is preferable for special work. One writer recommends the addition of 10 per cent. of *soft* scrap to each charge of the above, and while this would be contested by many founders, it is claimed to give very satisfactory results.—EDITOR, "F.T.J."

### Skin-Drying of Green-Sand Moulds.

Some years ago the writer was doing certain special work and used skin-drying. The method empolyed was as follows :—A trench was dug in the floor about 2 ft. deep, and towards the rear side was fastened an iron bar over the whole length of the trench, at the height of the flasks. Charcoal was then put in (coke




METHOD OF SKIN-DRYING MOULDS.

will do as well), and this ignited, and the hot air coming from this fire was used for skin-drying, the moulds being placed as shown in the accompanying sketch and left for half an hour or less, as required.

ROBERT WAGNER,
Chemnitz, Germany.

*Answer.*—In February issue of this journal "A. C. M.," Belfast, desires to know the best and cleanest method of skin-drying green-sand moulds. I have dried many moulds of all shapes with a fire made on a tin—any suitable piece of tin that would cover the mould. I have never tried making a fire on a plate, for the reason that it would be too thick for the heat to get through to the mould (I take it that when "A. C. M." says plate he means a fair thickness). In my present shop, which is one of the largest in the North of England, we can get old pieces of corrugated iron sheeting and make fires on them. Not only can skin-drying be so done, but moulds that have been wet-blacked and gum-washed, and which should have gone in the stove, have been dried in this manner—moulds that have been rammed up with the sand for dry-sand moulds, which every moulder knows must have a lot more drying than green-sand. Again, I have dried many moulds with a fire in a bucket; it is surprising what a lot of heat comes out of a bucket fire made up with small coke. To dry the top part of the mould I turn it over and put it on trestles so that the tin with the fire can be got on under it, as it catches more heat that way. Sometimes it happens that another moulder is wanting the fire after the bottom part is dried, and in that case a bag of shavings from the pattern shop may be blazed under the top, care being taken not to blister it with the blaze. Your correspondent will probably not find anything better or cleaner than a fire on a tin, as there are no cinders breaking the face of the mould by dropping on, as is the case with a grid fire.

"A WORKING MOULDER."

### Waster Castings.

I shall be glad if any of your readers could say what their experience has been in respect of waster castings, stated as a percentage of total net production of castings in terms (1) of weight, and (2) of value, over an extended period, or preferably for a year. In 1911—from a somewhat unusual combination of misfortunes—the writer experienced 7 per cent. Sharp, in his book, "Modern Foundry Practice," incidentally gives 2½ per cent. as an allowance for "losses for occasional bad castings, etc." The writer thinks his experience for 1911 is abnormal, but should like to know whether there is any figure that can be taken as normal. The work is "general jobbing," one-fourth being marine work.

"ENQUIRER."

## Electric Furnaces for Steel Making.

At a recent meeting of the forty-eighth session of the Cleveland Institution of Engineers, held at Middlesbrough, MR. HAROLD G. ADE STEDMAN, A.M.Inst.E.E., of the Cleveland and South Durham Power Company, Middlesbrough, read a lengthy Paper (of which the following are a few abstracts) on "The Electric Furnace Process as Applied to the Metallurgy of Steel."

Now that electricity has become almost universally adopted where energy in a flexible form, capable of perfect control, is required, and the economics which can be effected by its use have been fully demonstrated, due consideration to its claims as a thermal agent particularly in metallurgy, should be given. In the North-East of England no practical result can be recorded, but the use of electricity for metallurgical purposes is now an established commercial process abroad. The total number of electric furnaces in existence is not far short of 1,000, these being employed mainly in the manufacture of steel, iron, and non-ferrous metals.

Although a considerable number of electric furnaces have been patented, the number of distinct types in commercial use is comparatively small. The most successful type shows a striking similarity to an ordinary open-hearth steel furnace, the chief difference being that instead of the usual gas ports at each end, there are openings in the roof through which the electrodes enter and dip into the bath. One of the features possessed by this type is the absence of electrodes embedded in the hearth; that fact would probably appeal to most steel-makers who are accustomed to ordinary practice.

With respect to the electric process in the steel foundry, it is stated that the production of steel castings by ordinary methods leaves much to be desired; the metal is frequently spongy, unequal in appearance, and of varying composition. The production of steel castings by the electric process has been both technically and commercially successful from the very commencement, and not only so, but the improved quality produced has more than fulfilled the most sanguine expectations. Not only can clean sharp castings be produced of any size and composition, but their behaviour under mechanical tests is altogether in favour of the electrical method. It is quite easy to obtain castings of definite grades having tensile strengths up to 44 tons per sq. in., and owing to their being homogeneous throughout, the work of machining is facilitated, with considerable reduction of wasters. Based upon the most recent figures it should be possible on Tees-side to produce metal in the ladle for steel castings of the finest quality, with sulphur and phosphorus reduced to traces, at approximately £6 per ton if scrap is used, or £5 when finishing molten metal from converters. In contemplating in what direction development may occur, it would appear that such works as shipyard machine shops and engineering works generally promise a wide sphere of usefulness for the small electric furnace of from one ton upwards, producing castings from the waste material available, such as scrap, trimmings, turnings, and borings. In melting light scrap by ordinary methods it is quite usual to lose from 20 per cent. to 40 per cent. of the metal by oxidation, whereas there is only a few per cent. loss in the electric furnace.

High-grade steel can be produced in the electric furnace in all respects equal to that produced by the crucible method, with the added advantage that it can be made very much cheaper, in any desired quantity, and without the use of expensive and comparatively scarce raw materials. Only in the case of firms who require to make special steels, a few pounds at a time, differing considerably in composition, can the costly and troublesome crucible remain in the field much longer. With the passing of the crucible other districts, including Middlesbrough, will have no technical reason for not competing with America and the Continent for a share of the tool-steel trade. The crucible requires an expenditure of 60s. to 70s. per ton on coke alone for melting; the electric furnaces will both melt and refine such scrap material as rail heads at a cost of 24s. per ton.

### Discussion.

In the course of a lengthy discussion, MR. THOS. C. HUTCHINSON (managing director of the Skinningrove Ironworks) said that with respect to the electric process in the steel foundry, he had for some years had the acquaintance and confidence of the managing director of the Dommeldingen Works, in Luxemburg. He had discussed with that gentleman his project of an electric steel foundry, and his general scheme for steel refining. That project had been a success, and now there were turned out there over 1,000 tons of steel castings per month, varying in weight from many tons each to small castings for dredger buckets and cases for small motors.

MR. R. C. WHITFIELD (Middlesbrough) remarked that the cost of the production of ordinary steel was so low that it could not be touched, and it seemed useless to put down an electric furnace for ultra refining which was not called for. The electric furnace was, however, admirable for tool steel.

MR. VICTOR STOBIE (Sheffield) said he had used an electric furnace at Sheffield for fifteen months. People seemed to think the electric furnace would oust the crucible, but that was not so, any more than that the cupola should supersede the blast furnace. The electric furnace would create a realm of its own.

MR. H. MUNZING, engineers' tool merchant, 179, Upper Thames Street, London, E.C., has removed to 93-96, Union Street, Southwark, S.E.

MESSRS. WALTON & CLOUGH (successors to the Gilbert Little Company) have re-opened the Horton Works, Bradford, without any interruption of business.

THE SUMMERLEE IRON COMPANY, LIMITED, of 176, West George Street, Glasgow, have appointed Messrs. F. W. Jackson & Company, of 224, Corn Exchange, Manchester, to act as their agents for the sale of "Summerlee" pig-iron in Lancashire, Cheshire, and the West Riding of Yorkshire.

AN outbreak of fire occurred recently in the engineering works at 47, Summer Street, Bridgeton, Glasgow, occupied by D. Stewart & Company (1902), Limited. The switch-room and the electrical storeroom were completely gutted, and a portion of the flooring of the engineering shop was destroyed.

# Foundry Plant and Equipment.

## Electric Furnace for Non-Ferrous Metals.

An electric furnace for melting brass, drosses, scrap metals, and other non-ferrous metals and alloys which is novel in design, as it is a combination of the arc and resistance types, has been designed by the Pittsburg Electric Furnace Company, Pittsburg. The furnace, which is the invention of Mr. R. S. Wile, general manager of the Company, has been described in the "Iron Trade Review." The original furnace was of the stationary type and was used for smelting tin drosses. A tilting furnace also is built which embodies the same principles. This, in melting and pouring positions, is illustrated in Figs. 1 and 2, and Fig. 3 shows sectional views.

Four carbon electrodes are used, two extending through the bottom of the furnace and the other two entering through the top. When preparing to make a heat, the furnace is partially filled with broken glass and the carbon electrodes are arranged so that they almost come in contact with each other. An arc is thus formed, which soon melts the glass surrounding it. The glass in its molten state becomes a conductor of the electric current, notwithstanding the fact that previous to melting it is a non-conductor. After the glass has been melted the electrodes are drawn apart and the current passes through the entire glass bath, heating it to a high temperature, the glass becoming exceedingly fluid. The electrodes then are moved farther apart and the glass is maintained in a fluid condition. Until the glass is in this fluid condition no metal is charged into the furnace.

When the glass bath has reached a high temperature the metal is charged and sinks to the bottom of the furnace. The glass completely protects the metal from oxidation, thereby reducing the loss to a minimum. The glass is the resistance material for heating the charge and also protects the metal. Any kind of scrap glass can be employed, and it is not necessary to make a new charge of glass every time a heat is tapped. Tests have proved that the glass can be used for several months of continuous work, and when a new charge of glass is to be made, the molten glass is poured from the tilting furnace or is tapped out of the stationary furnace.

At Connellsville, Pa., two stationary furnaces have been installed for melting tin drosses and slags. This type of furnace is recommended for large melts, but for small heats the tilting furnace has proved exceedingly advantageous. The stationary furnace is built of firebrick, but it is essential to have a highly refractory lining to withstand the high temperature and corrosive action of the molten glass and metal. Chrome brick has given the best results. This brick is not only refractory and non-corrosive, but it also successfully withstands sudden changes of temperature. This is a feature of importance in the intermittent use of the furnace, as the repeated cooling and heating cause the brick to crack. The electric current used may be either direct or alternating, 110 or 220 volts. At 220 volts the charge of glass melts more rapidly at the beginning of a heat, but after the melting has begun the 110-volt current gives practically as good results. Carbon electrodes are used.

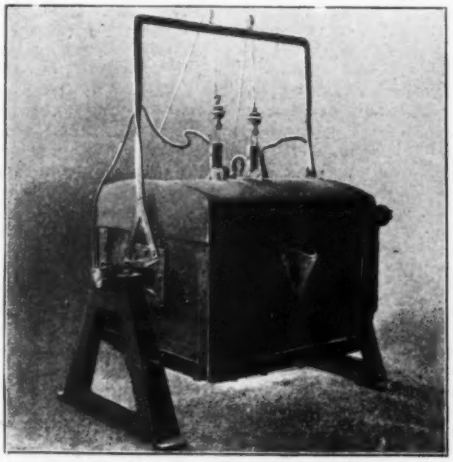


FIG. 1.—ELECTRIC FURNACE IN MELTING POSITION.

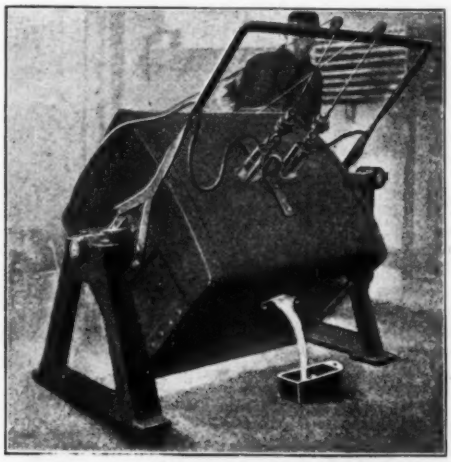


FIG. 2.—FURNACE IN POURING POSITION.

The tilting furnace is equipped with the same melting arrangement as the stationary furnace, with the exception that it is arranged to tilt to permit of easy pouring. For smelting drosses, scrap metals, etc., the stationary furnace gives excellent results, owing to the large quantities that are to be treated. The tap hole is plugged with an iron bar and when the melting operation is completed the bar is pulled out. The stationary furnaces are constructed in sizes up to 20 tons capacity, while the tilting types are made in various sizes up to 1,000 lbs. a charge. If the voltage of the current is sufficient, two furnaces may be connected in series and a corresponding economy in current may be obtained. The temperature of the molten glass may be increased to 5,500 deg. F., if necessary, without injury to the lining. A furnace melting a charge of 200 lbs. of brass will consume approximately 22 kilowatts of current at 100 volts. By connecting two furnaces in series a higher voltage may be employed, or the current can be cut down by a rheostat; if necessary, a larger furnace can be used. From a 200-lb. furnace a heat of this size can be poured in 30 minutes. A 500-lb. furnace consumes 32 kilowatts and a 1,000-lb. furnace will melt

a ton of brass every hour, and if run continuously will consume about 68 kilowatts in melting. Assuming that the furnace is not operated continuously and that electric current can be obtained for 1d. per kilowatt, it has been found that the current cost for melting 1,000 lbs. of brass will be 5s. 8d. This is

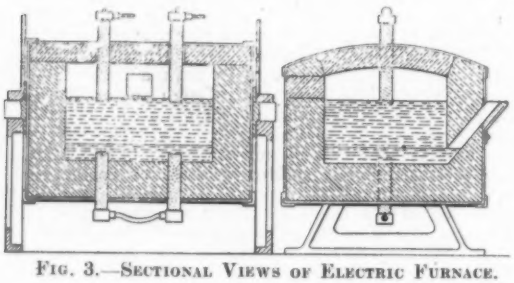


FIG. 3.—SECTIONAL VIEWS OF ELECTRIC FURNACE.

somewhat higher than melting with oil or coke, but the low melting losses are said to more than compensate for the extra cost of fuel.

As the metals are constantly covered with the molten glass, the loss from oxidation is exceedingly low; on new metals it may be as low as 0.33 per cent.

## Core-Sand Washer.

A new type of core-sand washer, fitted with a bucket conveyor, is illustrated herewith. This has recently been brought out by the Osborn Manufacturing Company, Cleveland, U.S.A. The capacity varies from 20 to 24 cubic yards in 10 hours, and 10 gallons of water are used for each cubic yard of sand washed. The sand is automatically conveyed from a pit at the side of the washer by a bucket conveyor, and into this pit the sand from the cleaning room is dumped. The washer is equipped with two discharge spouts, the one

THE OSBORN CORE-SAND WASHER.

delivering practically 90 per cent. of the recovered sand and only 10 per cent. of this sand is carried into the settling basin by the other spout. The sand is discharged into wheelbarrows at the front end of the machine for delivery to the core room. The drum of the washer is mounted on two V-shaped legs, reinforced with steel angles. The drum is belt-driven, and by the method of gearing adopted the use of a countershaft has been avoided. Hand-feed can also be applied to these washers if the automatic conveyor feed is not desired. The machine can be operated by one labourer.

## A Core Testing Machine.

For many years there has been a demand for some practical means of comparing the strength of various core binders. It is also often important to be able to compare the strength of different core mixtures as affected by changes in sand, oils and binders. Some five years ago, Mr. G. H. Wadsworth started a series of experiments on core mixtures. The work was carried on jointly by Messrs. G. H. Wadsworth and H. M. Lane, but was dropped for the time on account of lacking the equipment for making accurate determinations. During the past year the work has been taken up once more, and a number of manufacturers have collaborated to carry out the work. During the experimental work a number of different methods of testing cores were tried. Broadly, the choice lay between a tension and a transverse test. In the case of very strong cores, such as oil-sand mixtures used for radiators, some classes of fitting cores, gas-stove burners, etc., the transverse test on a 1-in. square core, 15 in. long, gave fair results, but it was difficult to turn out these large cores in quantity without rods and to be sure that they would not contain mechanical defects which influenced the strength. Then, too, the transverse test on bars of this length was not delicate enough to give a comparison between mixtures of approximately the same strength.

In testing the tension methods an ordinary Fairbanks cement testing machine was first employed, and this was found excellent for very strong core mixtures, but was not delicate enough for the weaker mixtures common in grey iron, brass, and malleable foundries. Accordingly the Wadsworth core-testing machine, shown in the accompanying illustrations, was developed. The core used is the shape of the ordinary concrete briquette, having an area of 1 sq. in. in the centre. The core is placed between the jaws when they occupy the position shown at the left, the jaws being closed together as shown at B. The illustration, however, does not show the core in place. The pail D is hung to the lower jaw so that it is supported by the core. The hopper E is filled with shot, and by raising the pin A to the top of the slot in the jaw, a small gate at the bottom of the shot hopper is opened and the shot allowed to flow into the pail D. As soon as the weight of shot in the pail becomes sufficient, the core breaks, and the jaws separate as shown at C in the central view.

As the lower jaw descends, it carries with it the pin A, thus automatically closing the shot valve. The jaw, however, is so arranged that the pail and jaw remain supported upon the pin A without coming in contact with the base of the machine. The pail is then lifted off and hung on the spring balances as shown at the right of the illustration. To get the full weight which it took to break the core, the lower jaw must be placed in the pail, or a weight equivalent to the jaw must be placed in it. This gives a direct reading of the weight necessary to break the core.

As soon as the reading is taken the pieces of the core are removed from the jaws, the shot poured back in the hopper, another core inserted, and the pail hung on once more, as shown at the left. The operation is very rapid, so that it is possible to test at least two cores per minute with ordinary mixtures. If it is desired to test a new lot of sand, oil or binder, two batches of cores are made with the same sand,

one using the old binder and the other the new, in the same ratio.

These cores should be baked on the same plate in alternate rows; they are then taken out, allowed to cool, and broken. The baking temperature will have considerable effect on the strength of the core, but it will effect both samples alike, so that with this method of procedure an exact comparison of the strength of the two binders is possible.

The machine illustrated is manufactured by the Wadsworth Core Machine and Equipment Company, Akron, Ohio, U.S.A.

## Association of Chemical Technologists.

The direct purpose of the Association of Chemical Technologists, which was founded on March 29, 1911, is to effect a radical change in the very unsatisfactory state of affairs which exists in connection with the application of chemistry to the arts and manufacturing industries in Great Britain, and which is operating against the commercial prosperity of the country. The objects of the Association may be summed up as follows:—

To extend the study and practice of applied chemistry so as to enable this country to compete industrially on equal terms with the most favoured and commercially progressive countries abroad; to broaden the field of operations for applied chemistry, and for the employment of applied chemists in Great Britain.

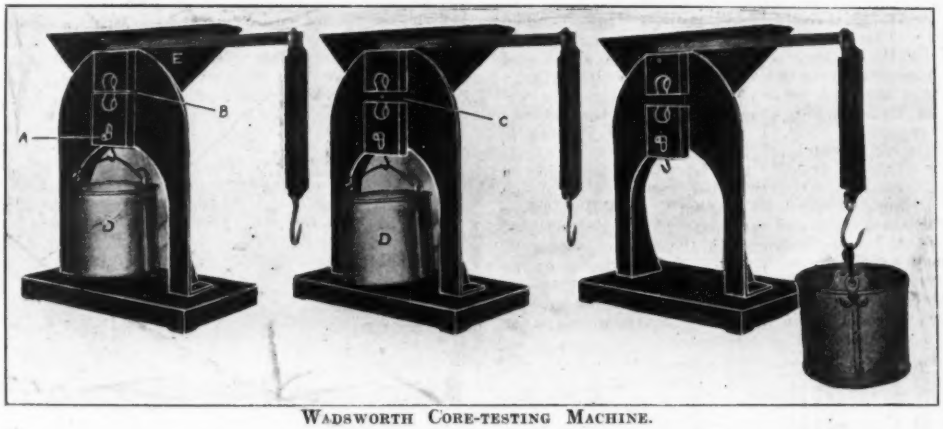
To place the profession upon such a sound and proper basis that the applied chemist may be at no disadvantage in comparison with his fellows in allied professions. To promote a wider general appreciation of the value to the country of applied chemistry, and to obtain for it from scientific men and from the public the active support and encouragement which, from its great economic importance, it deserves.

To encourage and to aid the adoption of applied chemistry as a profession, and thereby to promote the growth of a distinct profession of applied chemistry; and to effect the co-operation of such chemists for all matters which may directly or indirectly promote their interests.

To raise a fund to furnish grants for assisting persons approved by the Council of the Association to obtain training in applied chemistry at approved institutions or chemical works, either in this country or abroad, and to furnish grants for the prosecution of technical research. To maintain a register of members of the Association who are seeking technical appointments, and to inform them of suitable applications for their services.

To form district sections of the Association, each section to have its President, Honorary Secretary, and Council, with the object of enabling technical chemists to keep in touch with one another; to form a circulating scientific library to give members ready access to technical literature; and also to arrange for the publication in the official organ of the reports of meetings of district sections, technical papers, abstracts, descriptions of new patents, reviews of technical books and other information of scientific or general interest to technical chemists and to manufacturers.

The rapid development of the Association is proof that the need for such an organisation is strongly felt. The membership is already representative of over forty important branches of chemical technology, and the register contains the names of English chemists from all parts of the world.




WADSWORTH CORE-TESTING MACHINE.

The Secretary of the Association is Mr. J. Wilberforce Green, 30, Victoria Street, Westminster, S.W.

### Depreciation of Machinery.

MR. LLOYD GEORGE, in reply to Sir J. Jardine, in the House of Commons, on February 20, said that complaints regarding inadequacy of the rates of allowance for depreciation of machinery had been received from manufacturing and commercial bodies. The rates of allowance for wear and tear of machinery were not fixed by statute. The Commissioners, local or special, whose duty it was to assess the income-tax on trade profits, were empowered by law to allow such deductions as they might think just and reasonable, and he understood that the amount of the deductions had increased very largely of recent years.

THE Council of the Institution of Civil Engineers has established a "Civil Engineers' Appointments Board," with suitable offices and staff, to aid young members of the profession in want of engagements by informing them of suitable vacancies. The Board is composed of Sir Alexander Binnie, Lord Cowdray, Sir Alexander Kennedy, and Dr. J. H. T. Tudsbery.

PROFESSOR W. C. UNWIN was recently entertained to dinner by some two hundred of his old students, members of the Old Students' Association of the City and Guilds Central Technical College, in celebration of his year of office as president of the Institution of Civil Engineers. Mr. W. Duddell, president of the Old Students' Association, occupied the chair.

# Inventions.

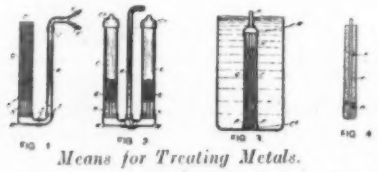
## Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

2,035.*New alloy. C. E. P. Gabriel.
2,081. Electric metallurgical furnaces. V. Stobie.
2,204.*Mould and process for making radiators. J. Porzel.
2,679.*Manufacture of metallic alloys. General Electric Company, United States.
2,709. Metallurgical furnaces. S. Cornthwaite.
2,749. Furnaces. R. H. Anderson and R. W. Bullick.
2,839. Crucible furnaces. A. C. Ionides.

## Abstracts of British Patent Specifications recently accepted.

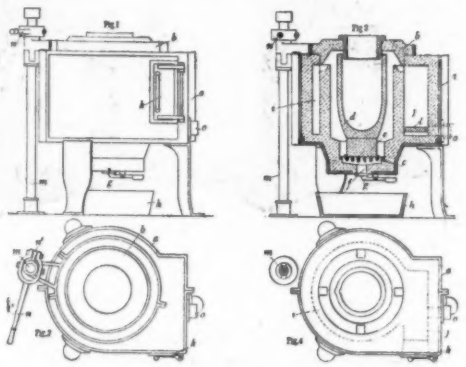
625 (1911). *Means for Treating Metals and Liquids by Heat.* W. A. Bone, the University, Leeds; J. W. Wilson, Carlton Works, Armley, Leeds; and C. D. McCourt, 13, Malwood Road, Balham Hill, London, S.W.—Fig. 1 is a sectional view of an arrangement adapted for the melting of metal; Fig. 2 is a sectional view of a modified form of the apparatus shown in Fig. 1; Fig. 3 is a sectional view of a burner adapted for the heating of liquids; Fig. 4 represents a further modified form of apparatus. Fig. 1 shows a burner adapted to melt alloys or metals of low melting point. C is an iron tube adapted to be immersed in a bath of metal, and provided with a gaseous mixture supply pipe A having suitable valves V, V¹ for the supply and regulation of the air and gas. Such pipe A leads downwards to the base of casing C, which may be a tube from 2 to 3 ft. in length, or, as desired, with a diameter of 3 in. or thereabouts—an elbow A¹ connecting the pipe A to the casing or tube C, which is provided with a fireclay entrance nozzle or



*Means for Treating Metals.*

plug N. The gaseous mixture passes through this nozzle into a bed of refractory granules G, by preference of magnesite crushed and broken to such a size as will pass a sieve of one mesh to the linear inch, the finer particles such as will pass a sieve of two meshes to the linear inch being taken out. The casing C is open at the top C¹ as shown. The mixture is ignited in the bed by first turning on the air, applying a flame to the open end C¹ and then turning on the gas until ignition occurs and combustion takes place at the base of the column of granular material, when the heat generated becomes rapidly communicated to the surrounding metal. The nozzle or plug in the casing C may be efficiently secured by winding the nozzle with asbestos string, and the whole exterior then plastered with a paste of burnt fireclay ground 30 mesh, mixed with viscous sodium silicate. The other joints as shown at J are preferably autogenously welded so as to prevent the possibility of molten metal entering at the joints. In Fig. 2 the casings C are in duplicate, and the outlet or top is provided with a hollow cap C², which whilst allowing the products of combustion to escape serves to reduce the noise which is made during combustion. The burner in Fig. 1 may also be provided with a cap.

3,640 (1911). *Gas Crucible Furnaces.* H. J. Yates, managing director of John Wright & Eagle Range, Limited, Essex Works, Thimble Mill Lane, Aston, near Birmingham.—Fig. 1 is a front elevation, Fig. 2 a plan, Fig. 3 a vertical section, and Fig. 4 a plan with cover removed of a furnace constructed in accordance with this invention. The body of the furnace is constructed from any ordinary refractory material contained in a suitable cast-iron shell *a*. At the base of the central chamber for the crucible (which chamber is open at the top and provided with a detachable cover *b*) a grid *c* is arranged for the support of either the crucible *d*, or a block *e* on which the crucible stands. An opening *f* to the exterior of the furnace is formed in the furnace bottom beneath the grid, and under the outer end of the opening is hinged a counter-weighted cover piece or flap valve *g*. Normally the opening is closed by the valve under the action of its counter-weight. In the event of accidental collapse or breakage of the crucible, the contents flow through the grid to the opening in the furnace bottom, and by their weight on the valve depress the latter and pass away into a pan or receptacle *h* placed beneath the furnace. Before escaping to atmosphere the hot gases are conducted through passages *i*, formed in the walls of the crucible chamber for the purpose of providing a hot jacket for the latter and enabling a high temperature to be maintained in the crucible chamber with an economical consumption of gas. The gases pass away from the jacket through an outlet *o*. Further, the passages are adapted at one part to provide a chamber *j* accessible through a door *k* at one side of the furnace. Ingots as *l* can be placed in such chamber and heated prior to their introduction to the crucible. The horizontal cover of the

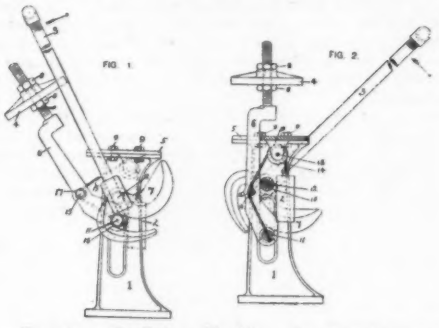


*Gas Crucible Furnace.*

furnace is preferably made to swing in a horizontal plane. For convenience in manipulating the cover it is secured at its periphery to a vertical spindle *m* upon which it is also capable of sliding vertically to a small extent. By means of a lever *n* pivoted at $n^1$ and arranged in conjunction with the spindle and the cover, the latter can be raised slightly off the upper side of the furnace and then swung into any desired position. A reverse operation brings the cover back on to the furnace top.

4,204 (1911). *Foundry Moulding Machines.* J. R. Moorhouse, 4, Ireton Road, Gipsy Lane, Leicester.—Fig. 1 represents a side elevation of a moulding machine embodying the invention; Fig. 2 represents an elevation of the machine with a side frame removed, to show more clearly the action of the balance weight in keeping the balance of the press plate, etc. The press head 4 is shown in a position clear of the moulding machine table, to permit the operator to fill the flasks with sand. It will be observed that the double-armed hand lever 3, fixed in the cam-plates 7, have their centre of rotation on shaft 12, and that the working edge of the cam-plates bear upon friction rollers 16 on shaft 11. Assuming the double-armed hand lever to be pulled down in a direction shown by arrow, it will be seen that the cam-plates 7 force the moving shaft 11 down the guides in side frames 1. This movement by means of the inclined projection on guide-stays 6,

sliding on the stop rollers 10 on shaft 12, will permit the press head 4 to assume a position directly over the moulding machine table 5, as shown in Fig. 2. From this position, if the motion of the double-armed hand lever




*Foundry Moulding Machine, by Moorhouse.*

be continued, the press head will drop in a vertical line governed by the sliding face of guidestays 6, being perpendicular to the moulding machine table 5. The guidestays are maintained up to the stop rollers 10 by means of chain 15, passing round the bar 13 fixed to the guidestays, and linking the balance weight 2 to shaft 11, as shown in Fig. 2. The balance weight is sufficient to keep the moving shaft 11 up to the working edges of camplates 7. The recessed portion of the camplates engages the friction rollers 16, on shaft 11, for that part of the stroke responsible for throwing the press head 4 clear of the moulding machine table. Upon raising the double-armed hand lever and pushing it back into the position shown in Fig. 1, this projection raising the shaft 11, forces that part of the guidestays 6 inclined to the major portion against the stop rollers 10, and thereby compels the press-head 4 to assume the position clear of the moulding machine table, by which the operator can remove the flask and replace it with another for squeezing.

## Personal.

THE late Mr. J. Tennent, of R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, left, in addition to real estate, personal estate valued at £55,227.

THE late Mr. W. Russell, a director of Fletcher, Russell & Company, Limited, Warrington, left estate of the gross value of £9,192, with net personalty £7,617.

KING ALFONSO has signed a decree conferring the Order of Naval Merit upon Mr. Albert Vickers, of Vickers, Limited, in connection with the building of the battleship "España."

THE late Mr. L. W. Adamson, lately chairman of John Abbot & Company, Limited, left estate of the gross value of £186,043, of which the net personalty has been sworn at £139,240.

THE gross value of the estate of the late Mr. J. F. Thomas, of Birmingham, retired brassfounder, is £10,760 8s. 3d., of which the net personalty is £6,449 2s. 2d.

MR. L. SERRAILLIER, manager, and Mr. R. W. Vawdrey, chief engineer, to the Indented Bar and Concrete Engineering Company, Limited, have been elected directors of the company.

MR. A. SCHWARTZ has resigned the Professorship of Electrical Engineering in the Manchester University and the School of Technology, on his appointment by the President of the Board of Education to a Staff Inspectorship in Engineering under the Board.

MR. T. H. DRYDEN has resigned his position with S. Fox & Company, Limited, Stocksbridge Works, near Sheffield, to take up the commercial management of the Skefko Ball Bearing Company, Limited, Luton, manufacturers of the patent self-aligning double row ball bearings.

MR. T. W. MAY, chief draughtsman at the Greenwich works of the Thames Ironworks, Shipbuilding and Engineering Company, Limited, was the recipient of a presentation on Feb. 10, the occasion of his retirement. Mr. May's connection with the works has extended over fifty-one years.

SIR WILLIAM H. WHITE has been elected by the Council of Bristol University, on the nomination of the Master, Wardens, and Commonalty of the Society of Merchant Venturers, as a member of the Board of the Faculty of Engineering, which is provided and maintained in the Merchant Venturers' Technical College.

PROFESSOR ARNOLD has accepted the position of Chairman of the Sheffield Committee in connection with the Exhibition of Non-Ferrous Metals and their application, to be held in London in May next. Several prominent Sheffield gentlemen are identifying themselves with the undertaking, among whom are Messrs. H. Barber (Daniel Doncaster & Sons, Limited), C. H. Wilson (Sheffield Smelting Company, Limited), A. Benton (Benton Bros.), J. W. Dixon (J. Dixon & Sons), and W. T. Haddock (Heeley Silver Rolling and Wire Mills, Limited).

## New Companies.

KIMBERLEYS (BIRMINGHAM), LIMITED.—Capital £1,000 in £1 shares, to carry on the business of tool manufacturers, etc.

ENGINEERING EQUIPMENT, LIMITED.—Capital £1,000 in £1 shares. Registered office: 48, Mount Stuart Square, Cardiff.

MASHAL ENGINEERING COMPANY, LIMITED.—Capital £10,000 in £1 shares. Registered office: 84, Major Street, Manchester.

HUNGERFORD ENGINEERING COMPANY, LIMITED.—Capital £3,000 in £1 shares. Registered office: Eddington, Hungerford, Berks.

C. E. RICHARDSON & COMPANY, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of mechanical engineers, etc.

E. S. P. SYND, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 2, Broad Street Buildings, E.C.

BRITISH AND OVERSEAS ENGINEERING SYNDICATE, LIMITED.—Capital £1,000 in £1 shares. Registered office: 4, Suffolk Street, Pall Mall East, S.W.

REYNOLDS STEEL INVENTIONS, LIMITED.—Capital £2,625 in 2,500 shares of £1 and 2,500 deferred of 1s. Registered office: 117-19, Birkbeck Bank Chambers, E.C.

MAJOR STEVENS & COATES, LIMITED.—Capital £5.000 in £1 shares, to carry on the business of engineers. Registered office: Abbey Works, St. James End, Weedon Road, Northampton.

WATSON & BIRKETT (LIMITED).—Capital £1,000 in £1 shares, to carry on the business of engineers, founders, etc. The first directors are Mr. H. H. B. Watson and Mr. H. Birkett. Registered office: Eastthorpe, Mirfield.

HOLDSWORTH & SONS, LIMITED.—Capital £20,000 in £1 shares, to carry on the business of engineers, boilermakers, etc. The first directors are Mr. A. W. Booth and Mr. W. Booth, both of Rodley. Registered office: Croft Boiler Works, Bradford.

HEAVY STAMPINGS, LIMITED.—Capital £60,000 in £1 shares, to carry on the business of iron, steel, brass and other metal forgemen, stampers, founders and manufacturers, etc., and to adopt an agreement with Richardsons, Westgarth & Company, Limited.

## Trade Talk.

THE TITAN PACKING COMPANY have removed from 2 and 3, Tower Royal, Cannon Street, London, E.C., to Dunstable, Beds.

THE foundries of the Staveley Coal & Iron Company, Limited, have been brought to a standstill owing to a shortage of coal.

THE firm of George McCartney & Company, engineers and ironfounders, Burnside Works, Cummock, recently celebrated their centenary.

THE DUDLEY TOOL AND IRONWORKS COMPANY, LIMITED, is being wound up voluntarily, with Mr. W. G. Podbury, 83, Colmore Row, Birmingham, as liquidator.

W. B. HAIGH & COMPANY, LIMITED, Globe Iron Works, Oldham, Lancs., have changed the style of the firm to W. B. Haigh, Gruban & Company, Limited.

A FIRE broke out on Feb. 13 on the premises of the Keighley Gas and Oil Engine Company, Limited, East Parade, Keighley, but the damage was very slight.

MR. W. P. BARNFIELD, of Midland Bank Chambers, Walsall, has been appointed liquidator of the Crescent Foundry Company, Limited, Crescent Works, Pleck Road, Walsall.

MR. BUGGETT, of the Crown Works, Chelmsford, has acquired the Anchor Engineering Works, Chelmsford, for many years carried on by Crompton & F. A. Fawkes, Limited.

MR. SHERARD COWPER-COLES has severed his connection with the Cowper-Coles Engineering Company, Limited, and has established offices at 1 and 2, Old Pye Street, Westminster, S.W.

THE DEUTSCHE SCHLEIFMATERIALIEN GESELLSCHAFT M.B.H., have established themselves in business at Steinach, Saxe-Meiningen, as specialists in abrasive materials of all descriptions.

MR. EDWARD SMITH, Brunswick Tube Works, Wednesbury, South Staffs., has converted his business into a private limited liability concern, and in future will trade as Edward Smith, Limited.

AN outbreak of fire occurred on February 17, in the Mungall Foundry, Carron Road, Falkirk, belonging to the Carron Company. The fire originated in the castings warehouse, which was gutted.

W. T. TOWLER & SON, LIMITED, engineers and boilermakers, Carpenter's Road, Hackney Wick, London, N.E., are being voluntarily wound up, with Mr. W. B. Peat, 11, Ironmonger Lane, London, E.C., as liquidator.

THE shareholders of the Star Foundry, Limited, will meet at the offices of Messrs. Guthrie & Guthrie, Bridge Street, Blyth, on March 29, to receive the report of the liquidator, showing how the winding-up of the company has been conducted.

ACCLES & POLLOCK, LIMITED, engineers and tube makers, of Churchbridge and New Meeting Street, Oldbury, have appointed Mr. T. M. Eastham, 151, Trevelyan Buildings, Corporation Street, Manchester, as their Manchester and Liverpool agent.

THE shareholders of A. E. Kitsell & Company, Limited, engineers and brassfounders, Willesden, N.W., have decided to voluntarily wind up the company. Mr. J. G. Godwin, of Godwin & Taylor, 195, Strand, London, W.C., has been appointed liquidator.

THE SANDYCROFT FOUNDRY COMPANY, LIMITED, Sandycroft, near Chester, have disposed of the sole right to the General Electric Company, of New York, to manufacture and sell in the United States of America and its colonies and dependencies, Cascade motors of the "Sandycroft-Hunt" patent type.

THE HOME SECRETARY has appointed Sir Ernest F. G. Hatch, Bart., to be a Commissioner to inquire and report whether the provisions of section 116 of the Factory and Workshop Act, 1901 (particulars of work or wages to be given to piece-workers), should be extended to foundries, and, if so, with what modifications.

OWING to the retirement through ill-health of Mr. Smith the firm of Ferrier & Smith has been dissolved as at December 30, 1911. The business of iron and brassfounders, engineers, etc., has been acquired by Mr. Ferrier who will carry it on under the name of W. N. Ferrier & Company, Penicuik Foundry, Penicuik, Midlothian.

A GENERAL meeting of Galloways, Limited (1895 Company), will be held at the office of Mr. J. W. Pollitt, 7, Pall Mall, Manchester, on March 15, for the purpose of having the liquidator's accounts, showing the manner in which the winding-up has been conducted and the property of the company disposed of, laid before such meeting.

MESSRS. A. MUSKER, W. C. MITCHELL and B. W. HEAD have made application for the restoration of the patent granted to them for "Improvements in ingot or casting extracting apparatus," numbered 9312 of 1906, and bearing date the 20th day of April, 1906, which expired on the 20th day of April, 1911, owing to the non-payment of the prescribed renewal fee.

A HEROULT furnace, capable of melting and refining 30 tons of steel per day, is being erected by Vickers, Limited, at their Sheffield works, as an extension of their present electric melting department. This extension indicates that the results of the process, which has been in continuous operation during the last twelve months, must have proved satisfactory to justify the considerable extension, and it is understood that a much larger increase in furnace capacity is probable in the future.

W. & T. AVERY, LIMITED, have just supplied to one of the Japanese railways a machine for testing the weight carried upon each wheel of the largest locomotives. It has a capacity of 360,000 lb., and while the locomotive is passing on or off the machine the platforms are locked, so that the 12 platforms (one for each wheel of the locomotive) shall not be jarred or jammed. While this apparatus is being actuated, the whole of the 12 patent aerostat indicating quadrants are simultaneously relieved, so that no shock or vibration shall interfere with the accuracy of the weighing mechanism.

AT a meeting of the members of the Gilbert Little Company, Limited, held at Tanfield Chambers, Hustlergate, Bradford, on January 24, a resolution was passed to the effect that it had been proved to the satisfaction of the meeting that the company cannot, by reason of its liabilities, continue its business, and that it was advisable to wind up the same, and accordingly that the company be wound up voluntarily. Mr. E. A. Mitchell, Tanfield Buildings, Bradford, was appointed liquidator. A petition for the winding-up of the concern will be heard at the County Court, at Bradford, on February 20.

CAMMELL, LAIRD AND COMPANY, LIMITED, have been engaged at their Grimesthorpe Works, Sheffield, on two ingots of unusual size. One has been rolled into a steel plate, which is claimed to be the largest ever made, forming the base of an armour bending and straightening press for a neighbouring firm. It weighs nearly 140 tons and was cast from three furnaces. The hydraulic press reduced its thickness from 4 ft. 6 in. to 3 ft. 6 in., and its eventual thickness was 2 ft. 7 in. Messrs. Cammell, Laird and Company have also on hand a 137 ton octagon ingot for a gun jacket, which is believed to be the largest ingot of that description ever made.

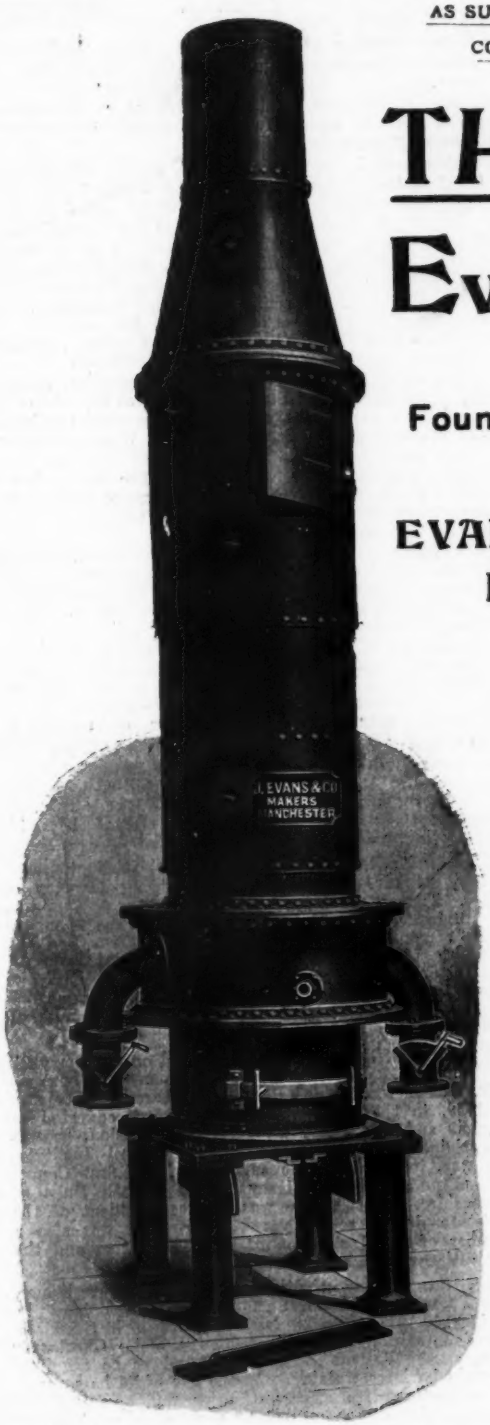
A MEETING was held recently at Manchester, for the purpose of forming a Manchester and District Committee in connection with the Exhibition of Non-Ferrous Metals and their Application to be held in London next May. Among those present were Professor H. C. H. Carpenter and Professor J. E. Petavel, of the Manchester University: Mr. L. Sumner (Broughton Copper Company, Limited), Mr. T. West (Johnson, Clapham, and Morris, Limited), Mr. J. Smithies, Mr. S. G. Harrison (Sykes and Harrison), Mr. R. W. Hanna, and others. Mr. F. W. Bridges, the organising secretary and manager of the exhibition, made a brief statement as to the object and scope of the exhibition, mentioning that Sir Gerard Muntz, immediate past president of the Institute of Metals, had accepted the position of president of the exhibition, and that most of the council and other officials of the Institute of Metals were either vice-presidents or members of the honorary advisory council of the exhibition. It was resolved to form a committee for Man-

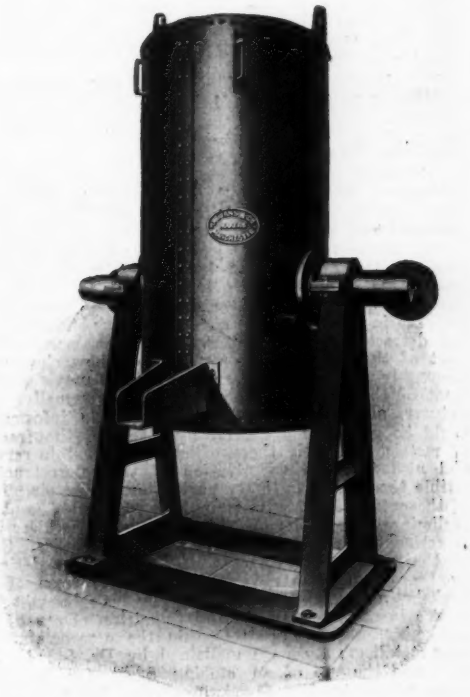
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

# THE Cupola.
# Evans's Rapid.

**Foundries Completely Furnished.**

## EVANS'S NEW CUPOLETTE
**For Emergency Work.**



**James Evans & Co.,**
Britannia Works,
*Blackfriars,*
*MANCHESTER.*

Telegrams: "LADLES, MANCHESTER."

chester, all present consenting to act, in order that Manchester might be adequately represented at the exhibition. A similar meeting has been held in Sheffield.

THE UNION STEEL CORPORATION OF SOUTH AFRICA, LIMITED, was recently registered with a capital of £250,000, divided in 247,500 7 per cent. preferred ordinary shares of £1 each and 50,000 deferred ordinary shares of 1s. each, the present issue consisting of 100,000 of the former. The preferred ordinary shares, in addition to receiving a preferential cumulative dividend of 7 per cent., will, after payment of a non-cumulative dividend at the same rate on the deferred ordinary shares, be further entitled to one-half of the remaining divisible profits in each year. The company propose to establish iron and steel works and rolling mills in the Transvaal, with a view to manufacturing drill and bar steel, iron and steel forgings and castings, etc., for which there has been for many years a large and increasing demand in South Africa. It is pointed out that hitherto all the requirements of the gold mines in this direction have been imported at heavy expense in freightage and transport. The Corporation will purchase from the Government railways, mining companies, and others their scrap and waste iron and steel, which has hitherto been shipped to Europe at almost nominal prices, and convert it into finished steel. The Government of the Union of South Africa have entered into an agreement whereby the Corporation acquire the preferential right to purchase iron and steel scrap from the Government railways and shops for sixteen years at £1 per ton for the whole of the Transvaal and a large district south of it, and at satisfactory prices for the remainder of South Africa. The Government have also agreed during the same period to increase the railway rates on exported scrap, and to grant the Corporation a reduced rate for transport of their scrap to the Corporation's works, and also to place their orders for such iron and steel goods as the Corporation produce with the Corporation. The Government reserve the right to nominate a director on the board.

The fourth meeting of the West of Scotland Iron and Steel Institute was held recently, in the rooms of the Institution of Engineers and Shipbuilders, in Scotland, 39, Elmbank Crescent, Glasgow. The president, Mr. Walter Dixon, occupied the chair, and Dr. J. E. Stead, of Middlesbrough, delivered a lecture on "Practical Metallography." The lecturer described the conditions most favourable to the application of this practical test, which is coming to be regarded as a most useful guide to the practical metal maker and metal worker. It was explained how valuable metallography was as a scientific research, but its use as an adjunct to practical work needed some considerable degree of experience in interpreting the results, which, however, did not detract from its immense practical value. A large part of the lecture was descriptive of how closely and accurately the microstructure revealed the previous treatment of the metal both physically and thermally. The lecturer also pointed out what valuable information could be got from a careful inspection of the fracture of metals, especially those which had failed in service, and also from an examination of the microstructure visible through an ordinary pocket lens. The simplicity of the outfit necessary was amply demonstrated, and the preliminary operation of fine polishing was described as eminently suitable for carrying out by ladies. Some of the simplest instruments used have been designed by Dr. Stead, who exhibited a portable form of his workshop microscope which has lately been brought into service in many workshops and foundries. Some of the ambiguities which have arisen in the nomenclature of steel metallography were explained by Dr. Stead. He advocated the use of an etching agent for tempered steels which he has found invaluable for a practical determination of the temperature to which the annealing after quenching had been carried. It consists of a 1 per cent. solution of nitric acid in isoamyl-alcohol. Some of Dr. Stead's latest researches have shown the great advance possible in knowledge of the effects of crushing strains upon metal as investigated microscopically, and he strongly recommended it as a guide to practice in steel foundries, steel casehardening shops, and also the rapid estimation of the arrangement of sulphur, phosphorus, and combined carbon in pig-iron as used in iron-foundries.

## Deaths.

MR. H. TONKINSON, of Messrs. Henry Tonkinson & Sons, ironfounders, Sunderland, died recently, aged 47 years.

MR. R. DOUGLAS, head of the firm of R. Douglas and Sons, Melville Lane Foundry, Montrose, died recently, aged 81 years.

THE death is reported of Mr. C. Braby, who managed the Deptford works of F. Braby & Company, Limited, London and Glasgow. He was fifty-one years of age.

MR. W. D. VAUGHAN, proprietor of the London Works Iron Company, iron, steel and tube makers, of the London Works, Oldbury, near Birmingham, died recently, aged forty years.

MR. G. BROOKE, an eminent American ironmaster, died recently at his residence in Birdsboro, Pa., aged 94. He was head of the E. & G. Brooke Iron Company, and the Birdsboro Steel Foundry & Machine Company.

THE death is announced of Mr. A. Gillespie, consulting engineer, of Bath Street, Glasgow, at the age of 73 years. For nearly thirty years the deceased gentleman was manager of the Barrowfield Iron Works, Glasgow.

THE death is reported of Mr. James Hind, of Sheffield at the early age of 36 years. The deceased was associated for many years with the firm of Burgon and Ball, manufacturers of sheep shears, of the La Plata Works, Sheffield.

THE death is announced from Paris of M. Georges Robert, one of the oldest of the French ironmasters, and chairman of the Compagnie des Forges de Champagne et de Canal Saint Dizier à Wassy, Saint Dizier, Haute-Marne, France.

THE death is reported from Paris, at the age of 69, of M. Delaunay-Belleville, one of the most distinguished personalities in the French industrial world. The deceased gentleman achieved fame as the inventor of the Belleville boiler and also as a maker of motor-cars.

THE death occurred recently, at his residence, near Leeds, of Mr. J. W. Hargreaves, a patentee of pumps and valves. At one time he was connected with the firm of Hathorn, Davey & Company, Limited, Leeds, as works manager, and afterwards became a director of the Leeds Engineering & Hydraulic Company, Limited.

THE death took place suddenly at Darlington, recently, of Mr. James White, managing director of Thos. Allan & Sons, Limited, Bon Lea Foundry, Thornaby-on-Tees. The deceased, who was about 60 years of age, took over the management of the Bon Lea Foundry 15 years ago. He formerly carried on an extensive business as a pipe manufacturer in Glasgow, and at the commencement of this year he became one of the principal partners in a very large business of iron merchants in London.

SIR JOHN G. N. ALLEYNE, Bart., died on February 21, at Falmouth. The deceased gentleman was born in 1820, and succeeded his father in the baronetcy, created in 1769, in the year 1870. Sir John was educated at Harrow and Bonn. An engineer by profession, he was an original member of the Iron and Steel Institute, and was, indeed, the sole survivor of the first Council formed under the presidency of the seventh Duke of Devonshire, in 1869. He was a Vice-President of the Institute during recent years. Sir John was also a member of the Institution of Civil Engineers and the Institution of Mechanical Engineers.

MR. JOHN TURTON died recently at his residence, Hill Turrets, Parkhead, Sheffield. He was born in Sheffield in 1843, and after leaving the Sheffield Grammar School entered the service of Messrs. John Charles & Sons, at the Kelham Rolling Mills, where he acquired his early business training. At the age of 25 he severed his connection with Messrs. Charles, and embarked on a commercial career on his own account, establishing himself at and devoting his energies to the development and extension from time to time of the business of John Turton & Sons, crucible steelmakers, etc., Vulcan Works, Ellin Street, Sheffield, in which he continued to take an interest to within a very short time of his death.

# PURE METALS

**and ALLOYS. FREE from CARBON.**

**TITANIUM THERMIT**

**for**

**SOUND, STRONG, CLOSE-GRAINED CASTINGS.**

**Also FERRO VANADIUM and FERRO TITANIUM.**

Full Particulars and PRICES from—

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# ELDERS FOUNDRY COKE

**AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.**

**The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.**

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

## Elders Collieries, Ltd., Cardiff.

## PRICES OF METALS.

The following table shows the approximate latest rices and position of stocks of metals during the pas wo years :—

| METALS. | End Feb., 1912. | End Feb., 1911. |
|---|---|---|
| Iron—Scotch pig warrants ton | *55/6 | *54/9 |
| —Middlesbro' warrants .. ton | 49/7½ | 48 8½ |
| —W.C. M/nos Bessemer ... ton | 67/0 | 68 0 |
| —Stock, Scotch ... ...tons | 1,000 | 1,000 |
| Copper—Chili bars, GMB ton | £64 5 0 | £54 15 0 |
| —Stock, Europe and afloat tons | — | — |
| Tin—English ingots ... ton | £199 0 0 | £187 10 0 |
| —Straits ... ... ... ton | £192 15 0 | £189 10 0 |
| —Stock, London, Holland, U.S.A., and afloat ...tons | — | — |
| Lead—English pig ... ton | £16 3 9 | £13 12 6 |
| Spelter—Ord. Silesian ... ton | £26 12 6 | £23 0 0 |
| Quicksilver (75lb)... bottle | £8 7 6 | £10 0 0 |
| Antimony—Regulus ... ton | £27 10 0 £28 0 0 | £32 0 0–£35 0 0 |

* Settlement price.

### CASTINGS.

In the Cleveland district the following are t nominal rates current for castings :—

| | £ s. d. | | £ s. d. |
|---|---|---|---|
| Columns (plain) ... ... ... ... | 6 10 0 | to | 6 15 0 |
| Pipes, 1½ to 2½ in. ... ... ... ... | 4 17 6 | to | 5 2 6 |
| ,, 3 to 4 in. ... ... ... ... | 4 10 0 | to | 5 0 0 |
| ,, 5 to 8 in. ... ... ... ... | 4 7 6 | to | 4 10 0 |
| ,, 10 to 16 in. ... ... ... ... | 4 7 6 | to | 4 10 0 |
| ,, 18 to 24 in. ... ... ... ... | 4 7 6 | to | 4 10 0 |
| Chairs ... ... ... ... ... ... | 3 12 6 | to | 3 15 0 |
| Floor plates (open sand) ... ... ... | 3 0 0 | to | 3 2 6 |

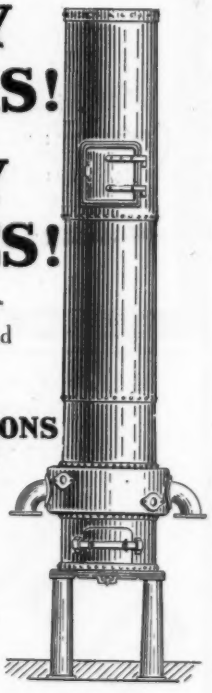
### SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 9s. 0d. ; light wrought, £1 5s. 0d. ; heavy cast, £2 9s. 0d. ; all per ton, f.o.b., London. Copper (clean), £59 10s. 0d. ; brass (clean), £41 10s. 0d. ; lead (usual draft), £14 15s. 0d. ; zinc, £21 5s. 0d. ; all per ton delivered merchant's yard

### Vanadium in Copper.

Vanadium has not, so far, met with any extended use in copper alloys, but it appears to hold forth considerable possibilities in connection with bronzes and brass. One alloy advocated for use with copper is composed of about 6.3 per cent. of copper, 13 per cent. of vanadium, and 20 per cent. of aluminium, the balance being made up by the usual other alloy ingredients. It is said to be possible to produce in a close mould sound and solid castings of copper, of a purity of 99.08 per cent., of a gravity of 8.93, and of very high conductivity. An essential point is to cast the copper of the degree of purity above-mentioned in closed moulds.

"ADAMANT CEMENT"
THE IRON CEMENT
FOR
FOUNDERS & ENGINEERS.
British Manufacture.
FREE SAMPLE AND PRICES FROM
SOLE MAKERS :—
CHARLES HALL & CO.,
WTOWN IRONWORKS,
Dixon Street, Dantzic Street,
MANCHESTER.

FOUNDRY CUPOLAS!
FOUNDRY LADLES!
Finest Workmanship and Materials.
SEND for QUOTATIONS
Our PRICES will interest YOU!
The DERBY BOILER Co., Ltd.,
DERBY.


GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams : "LOWOOD, DEEPCAR."

*Established 1863.*

# JAS. DURRANS & SONS,

## Phœnix Works, Penistone, Near Sheffield.

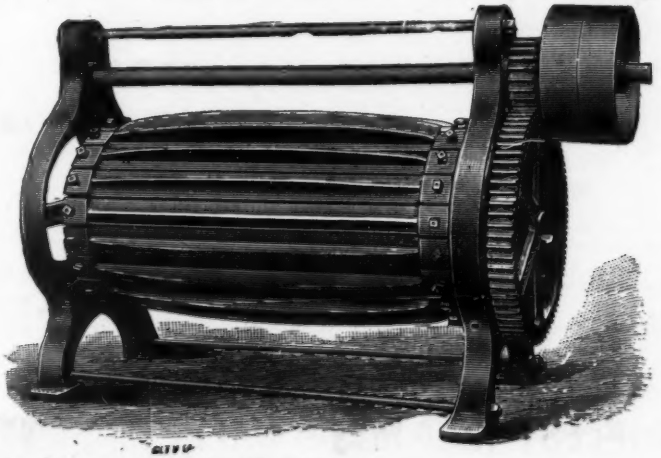
**Manufacturers of all**

## *FOUNDRY EQUIPMENTS*

**COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST**

**Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.**

## Improved Foundry Rattler or Fettling Drum.



**These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.**

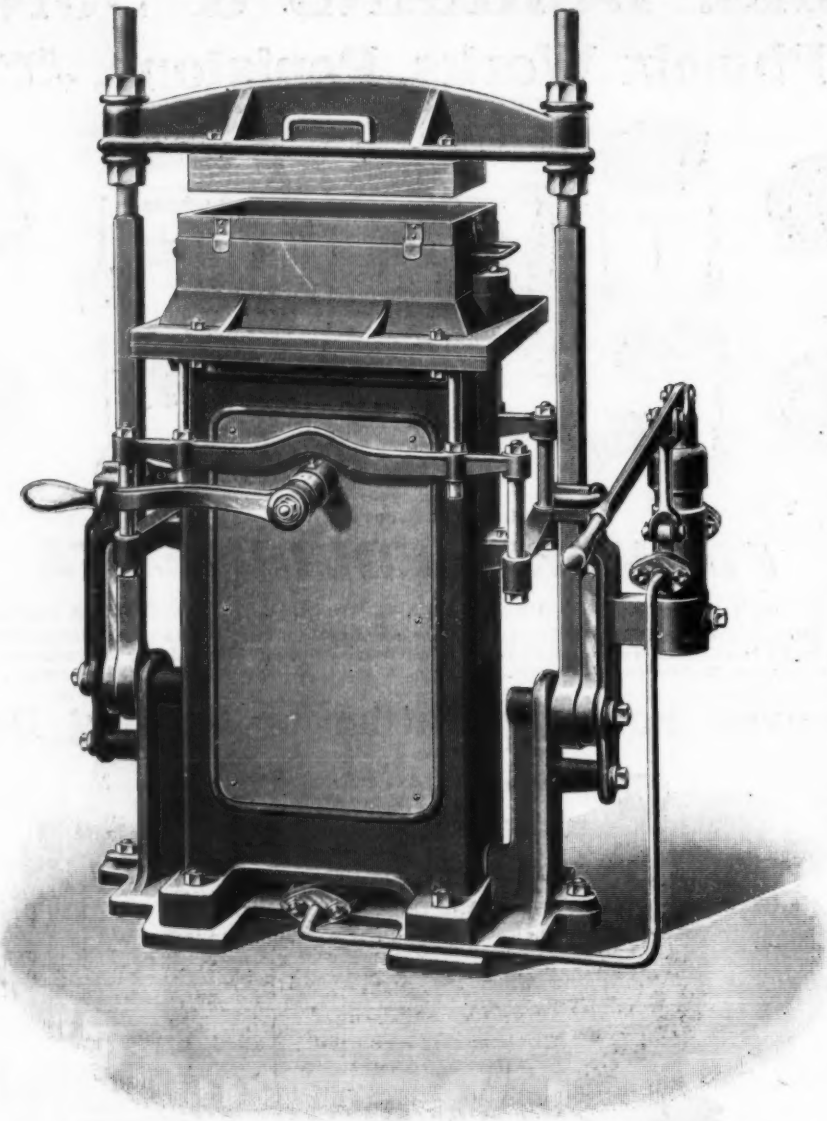
The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

# The London Emery Works, Co., PARK WORKS,

TELEGRAMS: "NAXIUM, LONDON." TOTTENHAM, LONDON, N. TELEPHONE: TOTTENHAM 158 (TWO LINES).



**Hydraulic Moulding Machine. Pattern P.**

## THE SIMPLEST AND MOST RAPID MACHINE MADE.

The working parts are so conveniently arranged and operate with such facility that a mould can be rammed and put down on the floor in $\frac{3}{44}$ minute. This means that the moulder can produce three times as many boxes as by hand and, further, every mould is perfect and all castings alike.

INVALUABLE in ALUMINIUM, BRASS and MALLEABLE IRON FOUNDRIES. Send us sample castings or drawings of your work and we will tell you what can be done.

**Sort them out Now, and Write To-day.**

# THE BUYER'S GUIDE

*Addresses and further information will be found by reference to the Firm's Advertisement.*

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**Air Compressors.**
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Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors (Electrically Driven).**
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors (Steam).**
Jackman, J. W., & Co., Ltd.
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Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors (Belt).**
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**Aluminium.**
British Aluminium Co, Ltd.

**Annealing.**
Evans, J. & Co.
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**Ash Crushing and Washing Machines.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

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Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
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Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

**Barrows.**
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Durrans, J., & Sons.
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

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Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

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Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.,Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

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Buffalo Forge Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Keith, J., & Blackman, Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.

**Blowers**—*cont*
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Ward, T. W., Ltd.

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Jackman, J. W., & Co., Ltd.
London Emery Works Co.

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Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
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Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

**Cement.**
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Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co

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Durrans, J., & Sons.
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
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Olsen, Wm.
Wilkinson, T., & Co., Ltd.

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Firminger, J. & Co., Ltd.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
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Sykes, James.
Walker, I. & I.

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Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

**Coal Dust.**
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Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.
Williams, John (Birmingham Sand) Ltd.

**Coke (Foundry).**
Elders Navigation Collieries.

**Coke Breakers.**
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

**Core Boxes.**
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Jackman, J. W. & Co.. Ltd.
Olsen, Wm.

**Core Compounds.**
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

**Core Gums.**
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

**Core Making Machines.**
Evans, J., & Co.
Hall, Charles & Co.
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London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

**Core Ovens.**
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Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
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London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.
Portway, C. & Son.

**Core Ropes.**
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

**Core Vents.**
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

**Cranes.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

**Crucibles.**
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

**Crucible Furnaces.**
Alldays & Onions Pneumatic Eng. Co., Ltd,
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

**Crucible Furnaces (Lift-out)**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

**Crucible Furnaces (Tilting)**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Crushing Mills.**
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Jackman, J. W., & Co., Ltd.

**Cupolas.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Derby Boiler Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

**Cupola Linings.**
Evans, J., & Co.
Hall, Charles & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
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**Emery Grinders.**
Alldays & Onion Pneumatic Eng. Co., Ltd.
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Jackman, J. W. &Co., Ltd.
London Emery Works Co.

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Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

**Facings.**
Evans, J. & Co.
Olsen, William

**Fans.**
Alldays & Onions Pneumatic Eng. Co., Ltd.

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Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
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Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

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Dyson, J. & J.
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Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

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Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sykes, James.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.
Williams, John (Birmingham Sand) Ltd.

**Foundry Brushes.**
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

**Foundry Ladles.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Derby Boiler Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros. Ltd.

## THE BUYER'S GUIDE.—*Continued.*

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Alldays & Onions
Davies, T., & Son
Durrans, J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London, Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

**Foundry Sand.**
Standard Sand Co., Ltd.
Dyson, J. & J.
Evans, J., & Co.
Gould, George
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

**Foundry Specialists.**
Naish & Croft.

**Furnaces (Annealing).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Furnaces (Brass).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Furnaces (Melting).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
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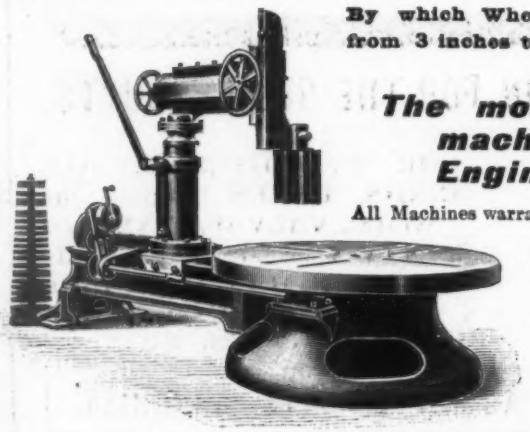

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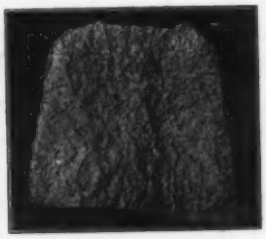
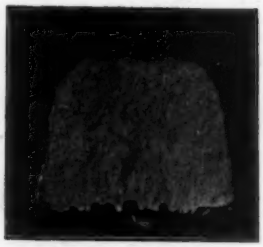

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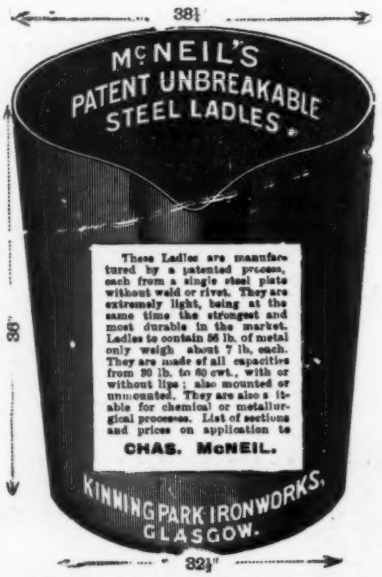
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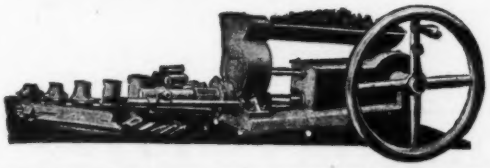

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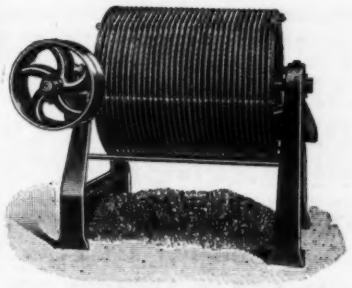

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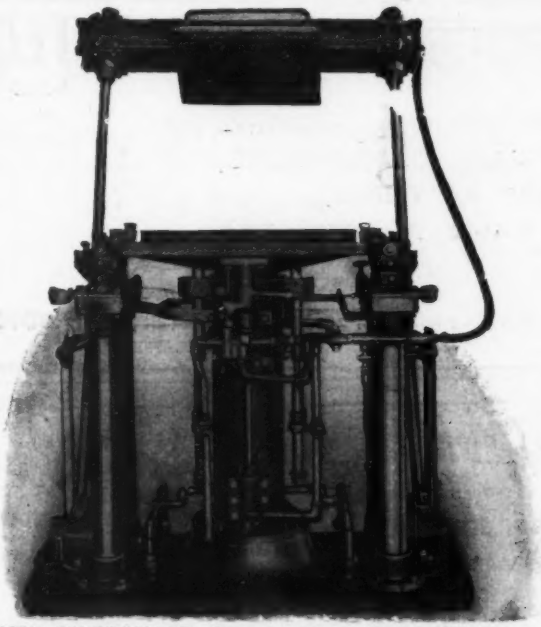

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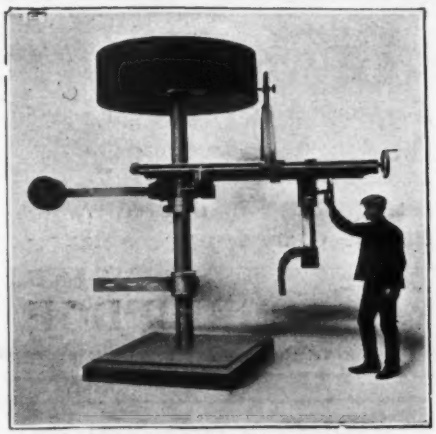

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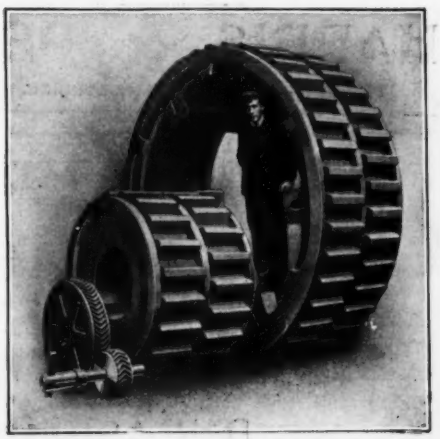

Wheels Moulded by this Machine.

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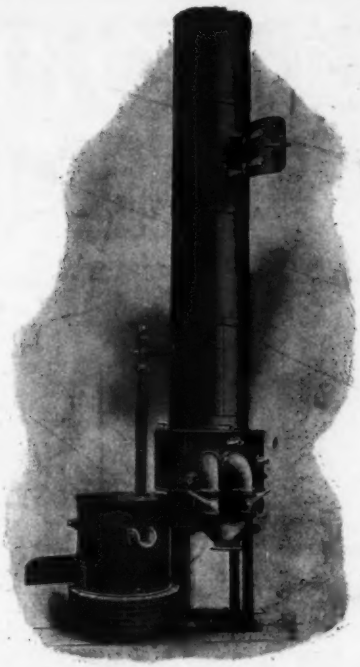

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